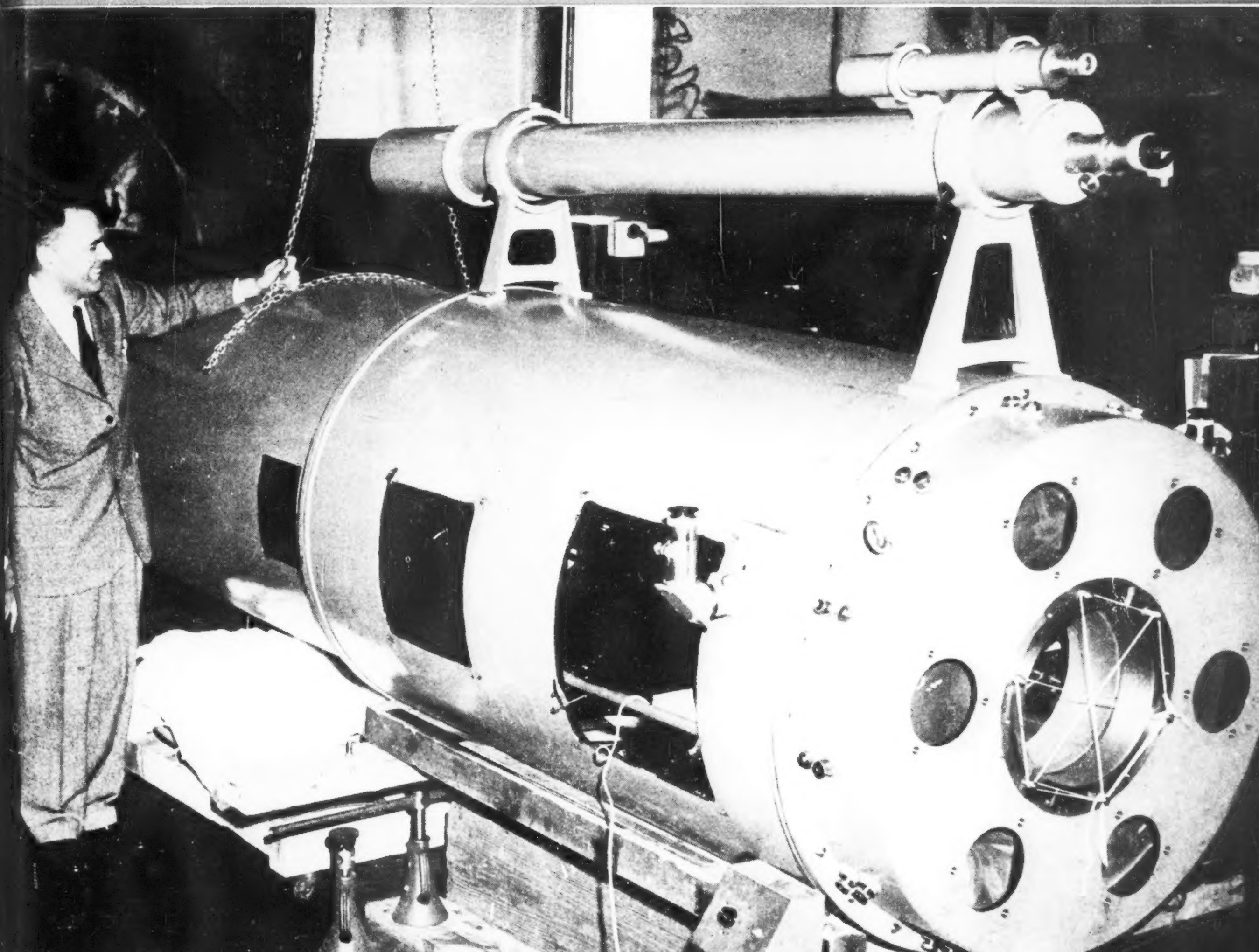
Sky and TELESCOPE



The ADH Baker-Schmidt

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In This Issue:

The Editors Note . . .

THE ASTRONOMICAL WORLD is currently involved in the problem of Dr. Immanuel Velikovsky and his disregard for tried-and-proven physical laws. A rash of advance publicity for **Worlds in Collision**, a book by Dr. Velikovsky under the Macmillan imprint, has appeared in numerous journals, led by the January **Harper's Magazine**, followed by **Collier's** for February 25th and **Reader's Digest** for March.

In the article, "The Day the Sun Stood Still," Eric Larrabee in **Harper's** outlines the "remarkable theory" that "about 1500 B. C. a comet, a new member of the solar system, [passed] close to the earth. . . . Fifty-two years later, at the time of Joshua, the same comet returned . . . . And with the shower of meteorites the earth stopped turning." Numerous Biblical stories, together with legends of American Indian tribes, Peruvian, Chinese, Aztec, and other groups, are cited by Dr. Velikovsky as supporting evidence. The "comet" is now supposed to be the planet Venus.

For authoritative arguments with which to combat these unorthodox ideas, refer to **Time** for March 13, 1950, and to **The Reporter**, March 14th issue, wherein Dr. Cecilia Payne-Gaposchkin, of Harvard Observatory, under the title, "Nonsense, Dr. Velikovsky!" writes in part: *

"The earth is a gigantic, massive flywheel. Its energy of rotation is immense. To stop its rotation the same amount of energy would have to be applied to it, and could be applied only by impact. A heavy body that merely passed by could not have more than a very small effect on the earth's rate of rotation, though it might disturb its motion in space — the length of year might be changed, but not the length of the day. If a body of the earth's density, about twenty miles in diameter, struck the earth at thirty miles a second, on the equator, and in the most 'favorable' direction, it would produce a change of *less than a second* in the length of the day. Even such a small body, if it fell on land, would produce a crater of spectacular proportions, hundreds of miles across and tens of miles deep. . . . What, then, would have been the effect of the impact of a body almost equal in mass and size to the earth, as Venus is? It would have pulverized the earth. *But nothing short of impact would stop the earth's rotation.*

"Let us assume, however, that Dr. Velikovsky is right — that the earth did stop rotating. In that case, all bodies not attached to the surface of the earth (including the atmosphere and the ocean) would have continued *their* motion, and would have flown off with a speed of nine hundred miles an hour at the latitude of Egypt. . . .

"We are told that 'Venus, as a result of an encounter with another body [Mars], took up its present orbit . . .' The orbit of Mars is, of course, *outside* the earth's orbit, the orbit of Venus *within* it. Both are nearly circular. It is inherently impossible for a body to perturb another body into a circular orbit smaller than its own. It may also be mentioned that as the mass of Mars is one-eighth of that of Venus, any effect produced by Mars on Venus would be reproduced *eightfold* by Venus on Mars; the supposed propulsion of Venus into its present orbit (even if dynamically possible, which it isn't) would have propelled Mars right out of the solar system."

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Sky and TELESCOPE

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CHARLES A. FEDERER, JR., *Editor*; HELEN S. FEDERER, *Managing Editor*

In Focus

BART J. BOK, Harvard's Milky Way astronomer, is now in South Africa preparing to probe the central regions of the galaxy. The chief instrument to be used in this research is the Baker-Schmidt telescope illustrated on the front cover, shown set up for testing in the optical shop of the Perkin-Elmer Corporation, Glenbrook, Conn., where Dr. Bok inspected the nearly finished instrument before he sailed late in February.

At that time the telescope was turned over to Director Harlow Shapley, in an informal ceremony attended by New York consular representatives of the Union of South Africa, Eire, and Great Britain. For this ADH instrument represents the combined planning and ownership of Armagh Observatory in North Ireland, Dunsink Observatory in Eire, and Harvard College Observatory. It will be placed on the mounting formerly carrying the 24-inch Bruce photographic refractor at Harvard's southern station, situated near Bloemfontein, South Africa. Astronomers from the three observatories will share use of the instrument.

The telescope is the first to be constructed of this type, designed by Dr. James G. Baker, formerly of Harvard and now associated with the Lick Observatory. It consists of a correcting plate, a primary mirror, and a secondary convex mirror. This and other variations of the same arrangement are free of spherical aberration, coma, and astigmatism. An important advantage over the Schmidt is that the field is accurately flat. The details of the various types are discussed on pages 104-109 of **Telescopes and Accessories**, by Dimitroff and Baker.

The tube length is considerably shorter than for a Schmidt system of the same equivalent focal length, for the secondary mirror reflects the converging beam of light back toward the primary. Thus, the flat focal plane is located a short

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COVER: Dr. Bart J. Bok, of Harvard College Observatory, inspects the new Baker-Schmidt telescope destined for South Africa and a co-operative program of Armagh, Dunsink, and Harvard observatories. (See In Focus.)

BACK COVER: The moon, aged 13.83 days, photographed on January 16, 1946, by J. F. Chappell, using the 36-inch refractor of Lick Observatory; enlargement, about 1.2 times from a contact print. (See American Astronomers Report for two accounts of current investigations concerning the moon.)

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Variable Stars and Stellar Evolution - I

BY OTTO STRUVE, *Yerkes and McDonald Observatories*

IN THE September, 1949, issue of the *Astrophysical Journal* Alfred H. Joy published the results of his observations of the spectra of variable stars in globular clusters. It has long been known that the globular clusters are rich in variable stars; Dr. Helen Sawyer Hogg has listed 1,300 objects in 60 clusters. Most of them are Cepheid variables of periods shorter than one day, designated as cluster-type variables or RR Lyrae-type stars. But 67 of the globular cluster variables do not belong to this group, because their periods are longer than one day, and their luminosities are greater than those of the normal short-period Cepheids. Among these stars of longer period, Joy discovered a considerable number whose periods range from 13 to 19 days, and whose light curves closely resemble the light curve of the galactic Cepheid variable W Virginis.

This latter star, with a period of 17 days, has been known for a long time to differ in the shape of its light curve and in its spectrum from the usual classical Cepheids of similar period. They are characterized by a very steep rise from minimum to maximum light, a narrow maximum, and a fairly steady decline toward a broad minimum, as shown here for SZ Aquilae. W Virginis, on the contrary, has a narrow minimum and a broad maximum, the latter being accentuated by a pronounced shoulder on the descending branch of the light curve.

Spectroscopically, W Virginis is even more unusual. It has bright hydrogen lines on the rise to maximum light — a phenomenon that is almost unique among the Cepheid variables of our galaxy. According to R. F. Sanford, it has double absorption lines while it is growing brighter, and it resembles in this respect the galactic cluster-type variable RR Lyrae, which shows the same strange doubling of the absorption lines.

Finally, W Virginis is located approximately 58 degrees from the plane of the galactic equator, which is also quite unusual for a Cepheid variable.

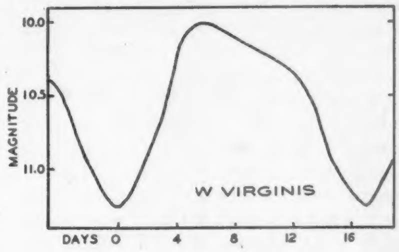
Joy's recent investigation shows that the Cepheid variables in globular clusters appear to duplicate closely the spectrum of W Virginis. They have emission lines and their spectral types are earlier, especially at minimum light, than are the spectral types of galactic Cepheids of similar period, and the G band produced by the molecule of CH is not seen. Similarly, these variables in globular clusters are intrinsically fainter than the corresponding individual Cepheids in the galaxy. Joy concluded that for some obscure reason ordinary Cepheid variables are exceedingly rare, or perhaps completely absent, in the globular clusters, and that the peculiar W Virginis group of variables is the only kind of long-period Cepheid that can exist in such a cluster.

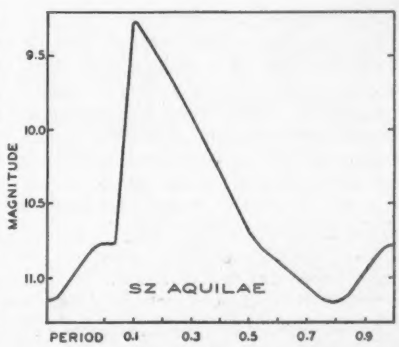
This conclusion, which was already anticipated by previous workers, leads us to suspect that the Cepheid variables are not a homogeneous system of pulsating stars, all of approximately the same physical characteristics, but consist of at least two different groups. Furthermore, the origin of the stars in globular clusters and their subsequent evolution may have been very different from that of stars which were formed in the spiral arms of our Milky Way system, where interstellar dust and gas abound even at the present time and may influence the manner in which the stars of the solar neighborhood develop. It is therefore interesting to look more in detail into the properties of galactic Cepheids of the W Virginis type.

We have already commented upon the unusual form of their light curves and upon their spectroscopic peculiarities. Still more striking is the large radial velocity of W Virginis, which Joy found to be 66 kilometers per second of approach. This value represents the average motion of the star with respect to the solar system. Considering that it is located much closer to the pole of the Milky Way galaxy than to the galactic equator, this large velocity suggests that W Virginis may be what is known as a high-velocity star, and it may therefore be related to other stars which are characterized by large velocities with respect to the solar system, our observing post.

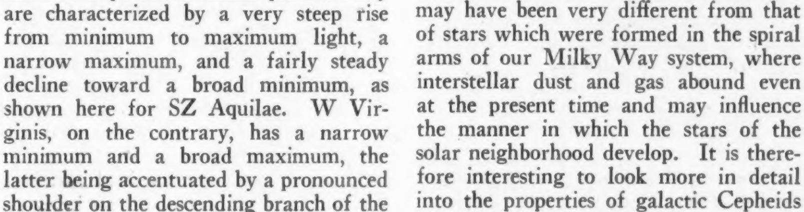
Unfortunately, we do not possess an accurate determination of the space motion of W Virginis, because its distance is so great that the proper motion cannot be measured with a sufficient degree of precision, and we therefore cannot determine the point in space toward which the motion of W Virginis is directed. However, inasmuch as this variable is located in galactic longitude 289° and part of its relative motion is toward us with a considerable velocity, it would not be unreasonable to suppose that its relative space motion is in the direction of the hemisphere centered at about 230°, toward which most of the high-velocity stars are apparently moving.

Apparently, then, we observe in the Milky Way a relatively small number of peculiar Cepheid variables which have unusual spectra and light curves, rapid motions directed toward one hemisphere of the sky, and which occur far from the central plane of the galaxy. These characteristics are typical for stars that W. Baade has classified as Population II, which represents objects that are most numerous in globular clusters, elliptical galaxies, the nuclei of spiral nebulae,





A comparison of the light curve of W Virginis (by Sergei Gaposchkin) with typical Cepheid SZ Aquilae (by Cecilia Payne-Gaposchkin), both from Harvard plates. The horizontal scales differ slightly, being in days for W Virginis, in tenths of the 17.14-day period for SZ Aquilae. The magnitudes are photographic.



McDonald Observatory spectra of W Virginis, the upper 1.0 days after the star's maximum light. The lower, 11.0 days after maximum, shows bright hydrogen lines (dark on the negative print) as the star increases in brightness.

and the nucleus of our own Milky Way system. The ordinary high-velocity stars are believed to be members of Population I that we see in the sun's neighborhood because they are temporary visitors from the nucleus of the galaxy.

The high velocity designation should really be attributed to the sun and its regular neighbors, for the stars in this vicinity tend to move in circular orbits around the galactic center with a velocity of about 275 kilometers per second. The "high-velocity" stars reach the vicinity of the solar system in greatly elongated orbits which have their nearest points to the galactic center located close to or within the nucleus of the system. In the solar neighborhood, some 30,000 light-years from the center, the high-velocity stars actually move with smaller velocities than the sun with respect to the galactic center, but they therefore appear to be moving at 60 or more kilometers per second in a direction opposite to that in Cygnus toward which the rotation of the galaxy takes place.

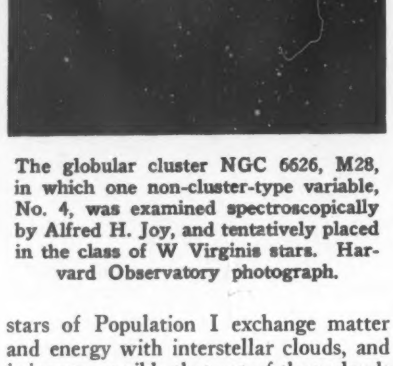
If the galactic variables of the W Virginis type are so intimately related to the Cepheid variables in globular clusters, it is significant that the distribution of the globular clusters and their motions closely resemble the distribution and motions of the high-velocity stars. Both are distributed with an approximately spherical symmetry around the nucleus of the galaxy and both have large systematic velocities with respect to the stars of the solar neighborhood. In fact, it seems that these spherical distributions of stars do not fully participate in the general galactic rotation, but are moving more or less at random in highly elongated orbits around the nucleus of the galaxy. If the latter could be considered a mass of infinitely small dimensions the motions would be given directly by the laws of Kepler. But in reality there is a gradual diminution of density in the galaxy from the center outward. We must therefore expect that the motions of the globular clusters and high-velocity stars are more complicated, resembling perhaps the precessional motions of the outer electrons in complicated atomic systems. Such electrons are also subject to a peculiar law of force when they approach the inner regions where the effect of shielding by the electrons near the atom's nucleus becomes important.

It is of particular interest to consider the cosmogonical consequences of this division among the Cepheid variables. All recent studies lead us to believe that the objects of Population II are old, while many objects of Population I — those that are characteristic of spiral arms in galaxies and of the solar neighborhood in our Milky Way system — are relatively young. There is an intimate relation between the spiral arms and the existence of dust and gas. The

The globular cluster NGC 6626, M28, in which one non-cluster-type variable, No. 4, was examined spectroscopically by Alfred H. Joy, and tentatively placed in the class of W Virginis stars. Harvard Observatory photograph.

stars of Population I exchange matter and energy with interstellar clouds, and it is even possible that out of these clouds stars are being formed which have rapid rotations and spectra of types *O, B,* and *A.* At the same time, there is a continuous flow of matter from these newly formed stars back into the interstellar cloud through expansion, rotational break-up, and prominence activity.

On the other hand, the inner parts of the galaxies, the globular clusters, and



A schematic diagram, looking down on the plane of the galaxy, shows the possible relation of the sun and the orbit in which a high-velocity star might move (not necessarily near the plane). The latter's actual speed would be high near the nucleus, low when in the sun's vicinity. At V in the diagram, the high-velocity star is observed among thousands of other stars. Most of these, revolving in orbits similar to the sun's, at nearly the same speed, seem to have low velocities. The high-velocity star, however, seems to be moving rapidly as a result of our own rapid revolution. The arrows represent the possible velocities of the sun and the high-velocity star.

the elliptical nebulae no longer possess any large quantities of dust and gas. These systems have long ago lost their blue and red giants whose lifetimes are shorter than a few tens of millions of years, and new stars are not being formed to replace them. The total amount of energy released by the conversion of hydrogen into helium can maintain a hot *B*-type or *O*-type star, or a cool supergiant of class *M*, for a few tens of millions of years, but not for a period of about three billion years, which represents the best estimate we now have of the age of the sun.

Hence, since our observations show that as a rule the globular clusters, the elliptical and irregular galaxies like those in Fornax and in Sculptor, and the nuclei of the spirals contain no blue or red supergiants but only stars whose lives can easily be measured in billions of years, we must suppose that in these systems the formation of new stars has ceased. Only the relatively less luminous stars remain, because they conserve their energies over long periods of time. The spendthrift supergiants have used up their available supply of hydrogen, to become faintly luminous objects of some as yet unknown variety.

It is a remarkable result that among the Cepheid variables we find two distinct classes, one of which — the W Virginis type — belongs to the group of old stars (Population II), while the other — the ordinary Cepheid — is closely associated with the young stars of the solar neighborhood (Population I). But we must remember that although W Virginis is not quite as luminous as are other Cepheid variables of similar period, it is nevertheless a very brilliant object compared to the sun. Consequently, it cannot continue in its present condition for billions of years. If the globular clusters are older than 10^8 years, their long-period W Virginis variables can have existed as Cepheid variables only during a short fraction of their entire lifetimes.

It is certainly very surprising that we should find among the old stars of Population II and the relatively young stars of Population I objects which are so similar in their properties as the variables of the W Virginis type and the corresponding cluster Cepheids of the same period. It is reasonable to suppose that they had a similar origin and evolution, and that the origin of the rest of the galactic Cepheids was somehow quite different.

I have described Joy's recent results because they present a striking example of the evolutionary consequences that may be obtained from a study of the variable stars. There are many other examples, some of them even more striking and suggestive, as we shall see next month.

(To be concluded)

TERMINOLOGY TALKS—J. Hugh Pruett

WHEN St. Paul 1,900 years ago wrote, "For one star differeth from another star in glory," he surely had no intention of making a scientific pronouncement, but he was enunciating the fundamental fact upon which the Greek astronomers near that time were building their system of classifying the stars according to their brightnesses.

Apparent Magnitudes

The credit for introducing the present method of designating a star's brightness is often ascribed to Hipparchus, who lived around 150 B. C. Others consider that Ptolemy, 300 years later and using the earlier astronomer's star lists, deserves the greater honor. The latter's system was generally used until long after the invention of the telescope. Hipparchus and Ptolemy graded the visible stars into six "degrees of lustre," which they called magnitudes. As 1st magnitude were included the brightest 20 of about 1,200 stars that were listed as visible from Alexandria, Egypt. The faintest the eye could detect were relegated to the 6th magnitude, and all the rest, with reasonable gradations, were included in the four magnitudes between. It is thus seen that the higher the magnitude number, the dimmer the star.

Ptolemy further subdivided each magnitude into three classes, making 18 in all. Some stars he listed as of average brightness for their magnitudes; others, as slightly more luminous; and still others, as a little fainter. The Greek letter mu was appended to the number to indicate "somewhat brighter," epsilon to show "somewhat fainter." Thus, in the 3rd-magnitude interval he had 3μ, 3, and 3ϵ.

Subdivisions of magnitude intervals into tenths were introduced as late as 1850, by Argelander, and these represent the finest gradations recognizable to the unaided eye, such as magnitude 2.6, 5.1. Today we think of a 3rd-magnitude star as one which lies in the range from 2.51 to 3.50; the 4th magnitude is the range from 3.51 to 4.50, and so forth.

After telescopes came into use nearly 350 years ago, multitudes of fainter stars never known to the ancients became visible. Magnitudes running into higher numbers were needed. But there was for a long while no uniformity in the systems used. An 8th-magnitude star in one astronomer's catalogue might be listed as of the 10th magnitude in another's. All this resulted in considerable confusion.

Magnitude Scales

In 1850, Pogson, an English astronomer, proposed the system that is now in general use. Sir John Herschel had found that an average 1st-magnitude star was about 100 times brighter than the faintest generally visible without optical aid. Why not assign a constant as the light ratio between the apparent luminosity of any given magnitude and that one magnitude brighter? Since there is a difference of five magnitudes from 6 to 1, we need a number, n, such that when multiplied by itself five times it will give 100. Therefore, n raised to the fifth power should equal 100, or $n^5 = 100$. Then n is a number which is the fifth root of 100.

Very few of us would relish the task of extracting the fifth root of 100 by "long hand." By logarithms, however, it is a simple task. We recall that in the logarithmic system commonly used the logarithm of a number is the exponent of 10 which will give that number. Since $10^2 = 100$, 2 is the logarithm of 100. Our number n is the fifth root of 10^2. This can be written as $10^{2/5}$ or $10^{0.4}$, and from proper tables we find that n is 2.511887. This is usually shortened to 2.512, or even more conveniently to 2.5.

Thus our ratio tells us that a standard 1st-magnitude star is about $2\frac{1}{2}$ times brighter than one of the 2nd magnitude; this, in turn, is $2\frac{1}{2}$ times brighter than a 3rd-magnitude star, and so on. The simplicity of the logarithm of 2.512 (0.4), makes it easy to calculate the ratio of brightness between stars of various magnitudes. For instance, how much fainter than the 6th magnitude is a star of the 22nd magnitude, near the limit of the 200-inch telescope?

The difference in magnitude is 22 minus 6, or 16. This is the number of times 2.512 must be multiplied by itself to give the ratio of brightness involved, which is, therefore, 2.512^{16}. The logarithm of this number is 16 log 2.512, or 16 times 0.4 exactly. The number whose logarithm is 6.4 is 2,500,000, approximately. This same result can be arrived at roughly without computation by noting that there are three 5-magnitude intervals and one more interval in the total of 16. For each five magnitudes the ratio is exactly 100; three of these equal 1,000,000, and the one more interval is $2\frac{1}{2}$ times that for a total ratio of 2,500,000.

Therefore, the 200-inch telescope will show stars at least $2\frac{1}{2}$ million times fainter than the dimmest visible to the unaided eye, that is, ignoring the difference between visual and photographic magnitude scales.

IN FOCUS

(Continued from page 130)

distance in front of the principal mirror. The curves necessary on the 32-inch correcting plate are about twice as deep as for an ordinary Schmidt. The 36-inch primary mirror is exactly spherical, and the 17-inch convex secondary only slightly off the sphere. The focal length is just less than 120 inches, and photographic plates $10\frac{1}{2}$ inches in diameter will cover about 20 square degrees of sky.

The plateholder will be loaded through the hole in the center of the mirror. The other holes in the back of the mirror cell, through which the mirror itself can be seen, will accommodate "pans" which will carry most of the main mirror weight when the telescope is in operation. Special care has been taken in providing means for fine adjusting of the two mirrors, but no adjustments are needed for the correcting plate. Provision has been made for the attachment of a 33-inch small-angle objective prism to the cell carrying the correcting plate, when it is desired to obtain spectra of all the stars in the field.

Guiding will be done with two microscopes (one shown in the picture) mounted at the side of the tube; these will be used to guide on a star image at the edge of the plate. Guiding may be done, especially on short exposures, by the large finder shown in the top of the picture. With this finder-guider, the guide star will also be at the edge of the field, for the inclination of the finder to the main body of the tube is $3\frac{1}{2}$ degrees.

The tube is in two sections, the upper with walls $\frac{1}{8}$-inch thick to carry the correcting plate, the lower with $\frac{1}{4}$-inch walls to support the two mirrors.

In the front-cover picture, the instrument is set up for testing the correcting plate. A 60-inch flat seen on edge in back of Dr. Bok is used in the testing. The cords across the opening in the mirror cell are used for rough alignment of the mirrors, and the side cover plates of the lower tube are open to permit the insertion of testing apparatus.

The instrument was to be shipped by the Perkin-Elmer Corporation at the end of March.

TOO MANY LEOS

Mosquitoes and frostbite may plague observers in the United States, but a member of the Astronomical Society of South Africa reports a different sort of annoyance. R. H. Bicknell says in the **Monthly Notices:**

"We have had two lions on the farm recently and observing has been very uncomfortable, as I have my telescope out in the open some way from the house."

Nevertheless, from July, 1948, to June, 1949, Mr. Bicknell made 500 variable star observations.

IMPERFECT MARCH ISSUES

A mistake in printing a portion of the March issue may have resulted in some subscribers receiving copies with the type on some pages trimmed off at the top. If yours is thus imperfect, please request another copy, but do not return the old one. ED.

AMERICAN ASTRONOMERS REPORT

Here are highlights of some papers presented at the 82nd meeting of the American Astronomical Society at Tucson, Ariz., in December. Complete abstracts will appear in the Astronomical Journal.

Stars of Type S

AMONG the reddest stars are those of spectral type *S*. They are distinguished by bands of zirconium oxide in the blue and yellow parts of their spectra. These stars are so faint, however, that very little is known about their light in the infrared region from 7000 to 9000 angstroms, lying just beyond the visible red.

During the summer of 1949, Dr. Philip C. Keenan photographed one of these stars, R Cygni, in this spectral region with the 69-inch reflecting telescope of the Perkins Observatory. His plates show a remarkable set of new bands from unknown molecules. Most prominent are bands extending toward longer wave lengths from heads at 7561, 8464, 8610, and 8820 angstroms. They are not due to zirconium oxide, which has only weak bands in this region, but evidently arise from some molecule that has not been thoroughly investigated in the laboratory.

In addition, the spectra of R Cygni have made it possible to measure more accurately the positions of the bands near 7400 and 7900 which had originally been found by Nassau and van Albada at the Warner and Swasey Observatory. These bands had been tentatively identified at the Perkins Observatory as due to lanthanum oxide, and this identification is now confirmed — the first known occurrence of this compound in the stars.

The new evidence supports and extends the suggestion by Dr. Paul W. Merrill, Mount Wilson Observatory, that in the atmospheres of the *S*-type stars the heavy metals are relatively more abundant than in the usual *M*-type stars, those having bands of titanium oxide. Thus, in the *S* stars such elements as rubidium, zirconium, and lanthanum are relatively more conspicuous than potassium, titanium, and iron, which are commonly seen in *M* stars. If this difference in chemical composition extends into the stellar interiors, it may be that stars of types *M* and *S* differ in their past histories.

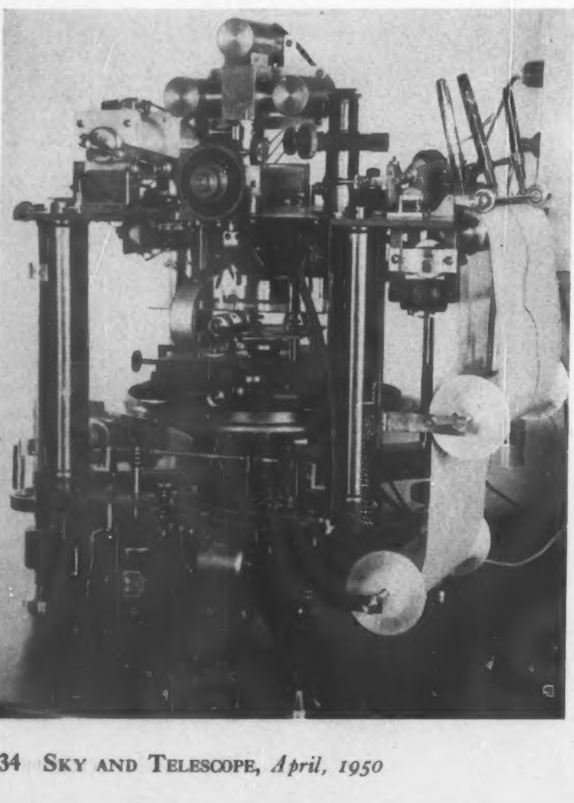
Lunar Profile

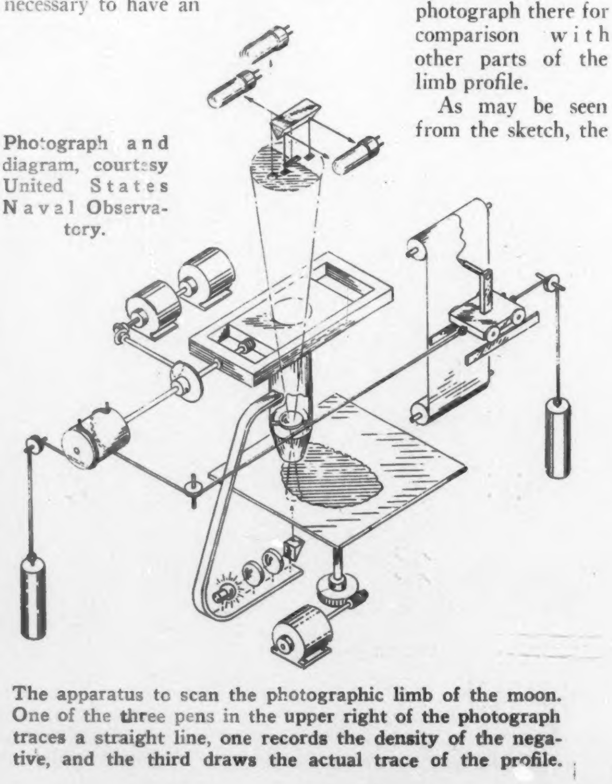
THE EDGE of the moon is rough and jagged, because there are many mountains and valleys that are seen in profile. As a result of the lunar librations, whereby we see around first one side of the moon and then the other, the features that form the lunar profile are constantly changing. For precise measurement of the moon's position in the sky from such events as occultations of stars, it is necessary to have an accurate knowledge of the character of the moon's limb for every possible libration position.

Therefore, a new survey of the marginal zone of the moon is being made at the U. S. Naval Observatory, by C. B. Watts and A. N. Adams. Photographs of the moon taken at the Southern Hemisphere station of Yale and Columbia observatories at Johannesburg, South Africa, beginning as long ago as 1932, and at the Naval Observatory during the past five years, are being measured. From some 400 or 500 profiles, a "topographic" map will be drawn to show the mountains and valleys along the edge of the moon.

The apparatus for scanning the moon's limb is shown here. Comparison of sketch and photograph may be made, beginning with the three photomultiplier tubes at the top of the sketch. By means of a prism, one of these tubes receives light from a narrow slit that lies across the limb of the moon. This slit is about 10 seconds of arc long and one second of arc wide. From two shorter slits, one just inside and one just outside the moon's limb, the second tube receives an equivalent amount of light. The third tube receives light from an area about 0.025 inch inside the limb, to measure the intensity of the photograph there for comparison with other parts of the limb profile.

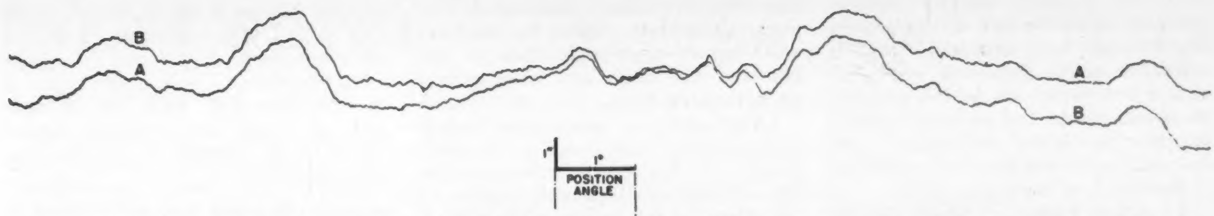
As may be seen from the sketch, the





Photograph and diagram, courtesy United States Naval Observatory.

The apparatus to scan the photographic limb of the moon. One of the three pens in the upper right of the photograph traces a straight line, one records the density of the negative, and the third draws the actual trace of the profile.



Uncorrected traces of two photographs of the edge of the moon taken within a few minutes of each other at the Yale-Columbia station in South Africa. The traces have been turned slightly about a point near the center of the diagram. Note the correspondence of B and A, but with small differences. U. S. Naval Observatory chart.

light that passes through the original photographic plate is first received by a micrometer microscope, and the position of this microscope along a radius of the moon's image is controlled by a servo-operated motor. A chopper mechanism alternately samples the output of the two principal multipliers, and if they are not balanced the servo mechanism operates to correct the position of the scanning microscope. Thus, the microscope follows the limb of the moon along a line of constant light intensity, as measured by the balanced output of the two photomultipliers.

The photograph is placed on a support that is turned at the rate of three degrees a minute by the small motor shown in the bottom of the sketch. The bright limb of the moon is scanned in one direction for 180 degrees; then the plate rotation is automatically reversed and the profile is redrawn, as a check against accidental and electrical disturbances.

The recording pen is shown at the right in the sketch, with its carriage connected to a small drum (at the left) that turns back and forth as the micrometer support moves in and out to follow the moon's contour. Another pen records the intensity output of the third photomultiplier, and a fixed pen draws a straight line on the paper, so that if the paper swells or shrinks the change in scale can be compensated.

The profiles drawn by the apparatus will have to be corrected for spindle errors, differential refraction, and eccentricity of the position of the plate on the mounting. Thus, there will remain considerable reduction work to be done even after all the photographs have been scanned by the machine. The horizontal scale of the drawn profiles is 1.6 inches per degree of position angle; the vertical scale, with the photographs used, is about 0.65 inch per second of arc of the moon's radius. The scale is of such great size that measuring can be done with ordinary drafting instruments. The probable error of a single profile point is about 0.05 second of arc.

Occultation Expeditions

DURING the past few years there has been a revival of the use of the moon for long-range triangulation in attempts to tie together the geodetic networks of countries on different continents, but it has been found that if we are interested in distances on the earth of the order of 50 feet or less, an improvement in our measurement of the moon's distance is needed.

When an occultation of a star by the moon is observed from two places whose distance apart is accurately established from triangulation surveys, then one side and two angles of the triangle that has the moon at its apex are known, and the distance to the moon may be calculated. But the accuracy of a single occultation observation has always been relatively low, partly because of the difficulty of making accurate visual or photographic observations, and partly because of the effect of irregularities of the moon's limb. It is expected that the new mapping of the marginal zone of the moon at the Naval Observatory, described in the preceding report, will aid materially in the limb irregularity uncertainty.

Meanwhile Dr. John A. O'Keefe, of the Army Map Service, has made use of the fact that observation points can be found from which a star will be occulted by practically the same point on the moon's limb. Strictly speaking, lunar librations make attainment of this ideal impossible, so a lunar feature which will dominate the limb for several hours is selected. Observations may be made along a line across the earth's surface that is similar to the narrow path of the moon's shadow during a total eclipse of the sun. Once the path has been calculated for a particular occultation, two or more mobile expeditions, with equipment mounted in trucks, are sent into the field to time the event from two or more places.

The observing apparatus is designed to overcome the difficulties inherent in the usual visual or photographic occultation observations. As a development of A. E. Whitford's photoelectric measurements of stellar diameters during occultations (see *Sky and Telescope*, VI, 1, November, 1946, page 7), the observations are made photoelectrically and recorded alongside radio time signals to an accuracy of thousandths of a second.

Calculation of the precise shadow path of the lunar feature, according to Nora B. Moser, makes it necessary to request the moon's positions from the British Nautical Almanac Office, tabulated with an extra decimal place. The earth's selenographic co-ordinates (librations) are computed from basic formulas rather than interpolated from published tables.

Changing Periods

ECLIPSING BINARIES are usually well-behaved double stars that revolve around and eclipse each other with clocklike precision. But some suddenly shift their periods to shorter or longer ones, while a few others seem to be changing period almost continually. Dr. F. Bradshaw Wood, Steward Observatory, has checked 546 stars in Pierce's finding list of eclipsing variables, and has found 18 well-observed cases which show unexplained fluctuations.

In seeking to explain these cases, Dr. Wood has applied criteria of stability to close binary systems. He points out that if a system is to be stable all parts of each star must be within what is known as the Jacobian limiting surface surrounding that star. Numerical computation shows that the shortest equatorial radius of the less massive star usually reaches the limiting surface first, providing a means for the escape of matter from the system. Of the 18 pairs above mentioned, 17 seem to be near this condition, which may account for their changes in period. Stars that have had constant periods over long observed intervals seem to be well within the stability limits.

Cases of the effects of a third body or of rotation of the major axis of the system are excluded from Dr. Wood's considerations. Hence, a change of period implies a change either in the combined mass of the components or in their separation or both. Eruptive prominences on the sun contain significant amounts of material being expelled with explosive force to distances which, in extreme cases, are of the order of the sun's diameter. In the case of the sun it is probable that this material eventually returns to the surface, but this need not be true for a highly distorted star located close to another star of equal or greater mass — as in many eclipsing binaries. Even if the eruptive forces were no greater than those observed on the sun, the more powerful eruptions would easily eject matter be-

yond the Jacobian limiting surface, where it would be lost to the system. Dr. Wood has computed that if 1/100,000 of the mass of a typical binary system were lost in this manner, the resulting increase in period would be appreciably larger than those usually observed, which are about one millionth of the length of the period itself.

To explain those cases where a shortening of period occurs it is necessary to consider the reaction of the expulsion on the motion of the star. As already described, material should be most easily ejected from the ends of the shortest equatorial axis of the less massive star. Because of tidal distortion, this axis lies about at right angles to the line joining the two stars and it therefore has a leading and a following end as the stars revolve around each other. Ejections occurring at the leading end would tend by reaction to slow down the revolution of the system; at the following end to speed it up. And in either case, the change of period could be of the order of 20 times that simply caused by the loss of mass involved.

Therefore, because of the reaction effect, the largest observed fluctuations can be explained by the loss of only one millionth of the mass of the system, and in actual cases losses of 10^{-7} or 10^{-8} may well prove more normal. Even such figures suggest that the condition of near instability, with intermittent or constant mass losses, could scarcely last more than 10 or 100 million years, if Dr. Wood's theory is correct. Thus, the near instability would be a temporary event in the life of such an eclipsing binary.

Six-Color Photometry

TEMPERATURES for 125 stars are being determined from measures of their brightnesses in six colors, in the range from 3500 to 10,000 angstroms, with the Crossley reflector of the Lick Observatory. Drs. Joel Stebbins, Gerald E. Kron, and J. Lynn Smith have adapted the Crossley to the Newtonian form, and a photoelectric photometer with interchangeable receivers has been installed. Improved circuits and a Brown recorder have been substituted for previous arrangements with a galvanometer. The work is a project under the Office of Naval Research.

For determination of the temperature scale, the stars have been compared with a standard lamp run at about 2,500° absolute. This lamp, with a small hole in front of the tungsten filament, serves as an artificial star which, operated by portable batteries, has been carried in a jeep to different peaks on Mt. Hamilton at distances of 1,000 to 3,000 feet from the telescope. Thus the real stars and the artificial star are measured under the same optical conditions, and the corrections for atmospheric absorption have been satisfactorily determined. The final values of the stellar temperatures will depend upon calibration of the photocell and filters now being carried on in the laboratory.

Other results of the program include a new group of light curves for the well-known star Eta Aquilae, the prototype for Cepheid variables with a pause in the otherwise steady loss of light from maximum to minimum. This "hump" or "stillstand" is present in all colors. In its period of seven days and four hours the star runs through a range in brightness of 4 to 1 in the ultraviolet, but only 1.5 to 1 in the infrared.

32 Cygni

THE SUPERGIANT spectroscopic binary 32 Cygni has been under observation at the University of Michigan Observatory for about 12 years. The spectrum is a fine example of superimposed spectra from a large cool star of class *K*5 and a smaller hotter star of class *A*. The latter is chiefly evident from the excess of ultraviolet light that partly "swamps" the spectrum of the *K*-type star. Now Dr. Dean B. McLaughlin has found that one star eclipses the other as they revolve around each other.

On November 1, 1949, the light of the *A*-type component had disappeared. An eclipse seemed to be the only logical explanation. This was confirmed by the changes in the spectrum that began November 10th. On that date the companion had just begun to reappear from behind the giant *K* star; the emergence probably took three or four days. On November 14th, the *A* star was shining through the deeper atmospheric layers that surround the *K* star, for lines of iron were strong and the lines of ionized calcium were of very great strength.

During more than three weeks, the *A* star emerged from behind successive atmospheric layers, and various spectrum lines weakened as it did so. The calcium lines, at first very wide and strong, grew narrower and weaker, but were still very outstanding on December 10th. A few lines of ionized titanium also lasted long, showing that those atoms occur very high in the atmosphere of the cool giant star.

The system is very similar to Zeta Aurigae, which shows similar eclipses and atmospheric absorption effects, as described by Dr. McLaughlin in *Sky and Telescope* for July, 1948. The period of orbital revolution of 32 Cygni is a little over three years. The distance between the stars is not yet known with accuracy, but is estimated as about 550 million miles, greater than from Jupiter to the sun. Diameters are probably 200 times the sun for the *K*-type giant, and five times the sun for the companion.

A comparison suggests that the eclipse of Zeta Aurigae is nearly central, while that of 32 Cygni is grazing. Probably the atmosphere of 32 Cygni is a little more extensive. The hydrogen atoms in the atmospheres of both Zeta Aurigae and 32 Cygni are probably excited chiefly by the radiation of the small, hot companion stars.

Comet Model Tests

AT THE Ottawa meeting of the American Astronomical Society last June, Dr. Fred L. Whipple, of Harvard College Observatory, discussed an "icy conglomerate" model for comets to explain the anomalous accelerations of certain comets and also possible reductions in the effective attraction by the sun. (See *Sky and Telescope*, October, 1949, page 308.) At Tucson, he presented further implications and tests for the theory that comets are composed of ices of compounds that are gases at room temperature, but frozen solid at the extremely low temperatures of outer planetary space, where a comet spends most of its life.

If 100 per cent efficiency in radiation transfer in the comet is assumed, an upper limit for the radius of seven comets is found to be, in kilometers: Biela, 1.7; Brooks, 1.2; D'Arrest, 1.4; Encke, 4; Pons-Winnecke, 82; Wolf I, 19; and 1905 III, 0.2. Dr. Whipple considers the smaller values probably the most significant; they are generally greater than the size of each comet indicated by the amount of light it reflects at great distances from the sun. The heat transfer efficiency can be estimated from these differences, and it is probably about 10 per cent for Encke's comet and nearly 100 per cent for Comet 1905 III.

The model predicts a large excess of unobserved hydrides, H_2O, NH_3, and CH_4 molecules, as compared to the observed C_2, CN, and ionized CO. Little visible radiation from these hydrides would be expected, however, and thorough observations of cometary spectra in the infrared are needed, as well as laboratory and theoretical studies.

Another requirement of the model is that a large cometary nucleus ejects visual or photographic meteoroids with greater velocities than does a small nucleus at the same perihelion distance (velocity proportional to the square root of the radius). Hence, the meteor streams from the greater comets should generally be more dispersed and more uniform from year to year than streams from lesser comets with comparable orbits. Confirming examples from greater comets are the Perseids (Comet 1862 III), the Orionids and Eta Aquarids, if these arise from Halley's comet. The Leonids (Comet 1866 I) and Bielids (Biela's, 1852 III) represent debris from dying comets. Quantitative studies are under way to check this qualitative agreement for meteor streams from known comets.

NEWS NOTES

BY DORRIT HOFFLEIT

MORE ON SEEING

No sooner had we reviewed the problems of seeing so well demonstrated by Gaviola's recent work at Cordoba Observatory (*Sky and Telescope,* January and February), than we received word of an article by H. Hartridge in *Nature* ascribing the twinkling of the stars to motions of the observer's eye.

According to the English authority on vision the eye is always in motion, resting on a given point only about a tenth of a second. The rod cells, which are brightness perceptors, do not all have exactly the same sensitivity. Hence, as the eye performs minute, involuntary, jerky motions, different rods come into play and the observed image flickers in brightness. He advanced experimental evidence such as the observation of considerable twinkling of electric lights at a distance of several miles. Yet when he observed the same lights through an 8-power telescope, the twinkling disappeared. The reason for this, he felt, was that the "star" appeared brighter in the telescope, and therefore small variations in the sensitivity of different rods were less noticeable.

The difference between nights of good and bad astronomical seeing is not explained by Hartridge's proposal. As for Dr. Gaviola's experiments on astronomical seeing, they involve photographic data only, and physiological optics definitely does not enter into our previous discussions.

UNESCO AND ASTROLOGY

"The Theory and Practice of Popular Science" is the title of a paper by Dr. David S. Evans, of Radcliffe Observatory, Pretoria, South Africa, that has been circulated by the Natural Sciences Department of UNESCO, 19 Avenue Kléber, Paris 16e, France. Such problems as the dissemination of scientific information by newspaper, radio, magazines and books, scientific films, and the spoken word, are discussed in detail, with many helpful and practical suggestions.

As an example of the seriousness of fake scientific prejudices, Dr. Evans cites the case of astrology, in part as follows:

"The wide-spread tolerance of astrological beliefs expressed normally in the phrase, 'There may be something in it,' seems to the writer to be a most important social symptom which in itself is a bar to a more rational treatment of social problems. . . .

"We may see in the fact that almost all journals in Britain and the U.S.A., except a few having an unusually high standard of social responsibility, carry an astrology feature, an expression of a renewed sense of insecurity in the future. If our political and social leaders cannot offer us a sure path to safety, if our intellectual leaders do not tell us how to save ourselves, what is more natural than that we should clutch at the straws of comfort provided by the astrologers and mystics even though our intellects may tell us that these men are charlatans?

"The exponent of popular science finds himself ranged as the implacable enemy of these cults of mysticism, and seeks to replace them by rational modes of thought."

BOSSCHA OBSERVATORY

During the war the Bosscha Sterrewacht in Lembang, Indonesia, was heavily damaged and its director and his two assistants were killed by the Japanese. UNESCO, with the aid of Netherlands and American astronomers, is planning the rebuilding of the observatory. Universities participating in the reconstruction will be Chicago, Leiden, and Louvain. A 36-inch reflecting telescope is planned. Situated in beautiful country with a good climate, at an elevation of 4,200 feet and seven degrees south of the equator, the observatory has many natural assets for astronomy.

PHILOSOPHY AND SCIENCE

"Science and philosophy were not distinguished sharply in antiquity," mourns Dr. Philipp Frank, of Harvard University, an authority on the philosophy of physics. "How to remarry science and philosophy, divorced in the 18th century," is a problem Dr. Frank hopes college students will consider seriously. As president of the Institute for the Unity of Science he has announced prizes totaling 500 dollars for essays on the subject written by college students and submitted during the year. Further information can be obtained from the Institute for the Unity of Science, American Academy of Arts and Sciences, 28 Newbury Street, Boston 16, Mass.

OTTO STRUVE TO GO TO BERKELEY

Dr. Otto Struve, chairman of the department of astronomy, University of Chicago, has accepted a professorship in astrophysics on the Berkeley campus of the University of California, effective July 1, 1950. He will assume the chairmanship of the department of astronomy, replacing Professor Sturla Einarsson, who retires June 30th.

The former director of Yerkes and McDonald Observatories will retain a connection with the University of Chicago as research associate, and he will continue some observational work at the McDonald Observatory.

NOVA LACERTAE 1950

Some 300 Harvard plates of the region of Bertaud's nova (see page 102, March issue), taken since 1892 and showing stars fainter than the 12th magnitude photographic, have been examined and on them no trace of the nova is found. On 11 plates taken with the 16-inch Metcalf refractor, however, a star of approximately magnitude 16.3 appears, and it may be the pre-nova star.

The large images of the nova after its outburst make comparison of its position with that of this faint star uncertain, and final identification must await the fading of the nova, which at its maximum was more than 10 magnitudes brighter than the possible pre-nova.

Dr. Balfour S. Whitney, of the University of Oklahoma Observatory, reports that three plates taken on January 18, 1950, show that the nova was then fainter than magnitude 13.5 photographic. The AAVSO observations of February 20th give the visual magnitude as 7.2, which is more than half a magnitude brighter than on the two preceding nights.

NEW WIRTANEN OBJECT

What is presumably a new asteroid has been found by C. A. Wirtanen, of Lick Observatory. On February 22nd, a stellar object of magnitude 14 was discovered in Ursa Major, and by March 1st it had moved westward into Camelopardalis. Dr. Leland E. Cunningham, Students' Observatory, Berkeley, found the orbit entirely indeterminate from the first observed six days' arc, and stressed the need for more observations. By March 16th, the object was expected to have moved all the way through Andromeda into Pisces.

In the CURRENT JOURNALS

EARLY DAYS AT MOUNT WILSON, by Walter S. Adams, *Popular Astronomy,* February, 1950. "The history of the origin and development of the Mount Wilson Observatory is primarily the story of the insight, enthusiasm, and courage of a single individual [G. E. Hale] . . . ."

THE ENERGY OF THE STARS, by Robert E. Marshak, *Scientific American,* January, 1950. "The radiation which ceaselessly floods interstellar space originates from the nuclear reactions of stellar interiors."

RADIO ASTRONOMY, by Martin Ryle, *Physics Today,* February, 1950. A member of England's famous Cavendish Laboratory describes how "another probe into space is available for examining bodies which are capable of emitting, reflecting, or absorbing radio waves."

Icarus and the Case of Vulcan

By J. Hugh Pruett, *Extension Division, University of Oregon*

A LAD of 12, who reads astronomy avidly, recently remarked to me that he wondered if the little asteroid 1949MA, discovered June 26, 1949, by Dr. Walter Baade at Palomar Mountain, could by any chance be the hypothetical planet Vulcan. He based his "wonder" on the coincidence that Icarus at times loops into the private domain of Mercury and that Vulcan, of which so much was said in the late 1800's, was supposed to revolve around the sun on an intra-Mercurial orbit.

There is, of course, a similarity between the two as far as occasional or continuous proximity to the sun is concerned. Yet, from the faintness of Icarus even when nearest the earth (12th magnitude), it seems certain that it is entirely too dim to fit the descriptions of the object reported last century as seen near the sun during an eclipse and at other times transiting the solar disk as a dark spot.

The name Vulcan seemingly came into use astronomically around the middle of the 19th century. Some attribute its introduction to Leverrier, the noted French astronomer, whose careful calculations on the irregularities of the motion of Uranus led to the discovery in 1846 of Neptune. In ancient mythology Vulcan was the god of devouring flame.

It has long been known that the perihelion point on Mercury's orbit advances at the rate of 574 seconds of arc per century, all but 43 seconds of which can be explained by the gravitational action of all the other planets. Leverrier, exulting in his success over the discovery of Neptune, turned his attention to the problem of Mercury. His calculations (he thought there was an unexplained 35 seconds only) convinced him that the presence of a planet — or perhaps several planets — inside Mercury's orbit would entirely clear up the difficulty of the perihelion advance. He did not assert such a planet did exist, but said that such an existence would explain all.

In 1859, it was thought that the elusive Vulcan had at last been run down. The French physician and amateur astronomer Lescarbault, who lived at Orgeres, a town southwest of Paris, was observing the sun telescopically on March 26th. He found a small, very round, black spot on the solar face which he was sure was not an ordinary sunspot but a tiny planet in transit across the disk. Leverrier heard of this and later interviewed the physician. The great mathematician seemed convinced that the intra-Mercurial planet of his dreams had been found. He calculated its mean distance from the sun as 13 million miles — about one third that of Mercury. Simple calculations by trigonometry show that such a body would never appear more than eight degrees from the sun.

The French astronomer M. Liais, engaged at the time in some scientific work in Brazil, heard of the reported sighting of Vulcan. He was inclined to ridicule bitterly the supposed discovery. He heaped criticism also on Leverrier for abetting such a scientific fraud. Liais declared he was observing the sun at the very time reported by Lescarbault, and with a telescope twice as powerful, but he saw nothing but ordinary spots on Old Sol's countenance.

Lick Observatory solar eclipse equipment at Cartwright, Labrador, in 1905. At the right is the "Vulcan" telescope, consisting of four small cameras on a single mounting pointed at regions near the sun. Results: negative.

Long afterwards, Lescarbault's reputation as a well-informed observer was considerably discounted when he reported to the Academy of Sciences that on January 11, 1891, he had discovered a brilliant new star that had broken out in Leo. His "noted" discovery was soon found to be none other than staid old Saturn.

In 1860 and 1861, more observations of Vulcan were eagerly attempted, but without success. However, on March 20, 1862, an observer named Lummis, of Manchester, England, was sure he spied the elusive little world. Records were searched and accounts of earlier viewings were seemingly found. A Mr. Stark apparently had seen the same object on February 12, 1820. Scott near London, using a 4½-inch telescope, and Wray, at another location at the same time and with a 6-inch, were sure they saw a planet on the solar disk in June or July, 1847. Weber on April 4, 1876, saw a similar object.

Belief in the reality of Vulcan received its greatest support at the time of the total eclipse of July 29, 1878, and at the hands of Lewis Swift, of Rochester, N.Y., and Prof. James C. Watson, of the University of Michigan. Swift was rated as an amateur astronomer, but as the operator of the finest observatory in the country — the principal instrument was a 16-inch Clark refractor — and the discoverer of many comets and nebulae, he gained worldwide fame.

During the eclipse of 1878, Swift observed near Denver, and Watson at Separation, Wyo., near the summit of the Rockies. Swift was certain that he saw two Vulcans. He tells his story in *The Sidereal Messenger,* predecessor of *Popular Astronomy,* in the early '80's, and was widely quoted by others. He claimed that he saw two red "stars" which were as bright with his 4½-inch refractor as Polaris is to the naked eye. They were three degrees west of the sun and six or seven minutes of arc apart. He was positive there were no "fixed stars" of that description in that part of the sky. Three times as he swept this region this wide, red double swam into view. Swift reported that at another location Trouvelot and his assistant saw a single red star. Swift took no stock, however, in the idea that Vulcan had ever been seen as a dark spot in transit across the solar disk.

Professor Watson also used a 4½-inch telescope at his station. He found one "ruddy object with a disk too big for a star." He thought it was beyond the sun and was sure it was an intra-Mercurial planet. J. Norman Lockyer, writing about this later, remarked, "If it will fit one of Leverrier's orbits and should turn out to be Vulcan, astronomers will doubtless keep a firm grasp on

it." Prof. Charles A. Young, of Princeton, doubted the discovery, however, and called attention to the fact that such astronomers as Newcomb, Wheeler, Holden, and others, had found no unusual bodies.

During the remainder of the century, efforts to glimpse Vulcan again met with no success. By 1905, even the most rabid believers in this mysterious little body had about lost hope. Photography was by that time well established as an astronomical tool. In 1909, Prof. W. W. Campbell, director of Lick Observatory, writing in the May issue of *Popular Science Monthly,* discussed what he called the "closing of a famous astronomical problem." He thought it quite certain that none of the reported observations of an intra-Mercurial planet had any foundation of fact. He mentioned that during the 20 years previous to 1909 the sun had been photographed every clear day, but no transit of Vulcan had ever been suspected. And during total solar eclipses all stars down to the 9th magnitude were recorded photographically, but no unknown body had been discovered.

During the past 40 years, Vulcan has never been caught coming out of hiding. In 1915 Einstein's theory of relativity took care of the full 43 seconds of mysterious discrepancy in the centennial advance of the perihelion of Mercury's orbit, so no longer is Leverrier's explanation needed. The consensus of opinion has long been that there is no planet revolving entirely within the orbit of Mercury. Except for comets, Icarus is the only known invader of that domain.

BAADE'S ASTEROID NAMED

In June, 1949, Dr. Walter Baade discovered an unusual asteroid on an early plate taken with the new 48-inch Schmidt telescope on Palomar Mountain. As described by Dr. Robert S. Richardson in the September, 1949, issue of **Sky and Telescope,** it is the only known asteroid with its perihelion inside the orbit of Mercury. At closest approach to the sun, this small body, believed to be about 0.9 mile in diameter, must get as hot as 1,000° Fahrenheit. At its greatest recession from the sun, outside the orbit of Mars, its temperature is below the freezing point of water.

The appropriate name selected by Dr. Baade is **Icarus,** after the mythical youth who escaped imprisonment by wings attached to his body with wax. His enthusiasm for flight led him closer and closer to the sun, whose rays melted the wax, and he fell into the sea. In Minor Planet Circular No. 347 it is stated that the name Icarus was suggested by R. C. Cameron, of Indiana University, and by Dr. G. E. Folkman, of Clemenon, Mich.

It is expected that Icarus will play an important role in solar system astronomy, because a measure of the gravitational pull exerted by Mercury on this small body will lead to a better value for the now uncertain mass of Mercury.

The February Outburst of Sunspots

ON FEBRUARY 15th, Mrs. Lucy T. Day, at the U. S. Naval Observatory, called attention to the large number of new spots on the sun. As indicated by the second of the accompanying series of photographs, the total area was 4,900 millionths of the sun's hemisphere, whereas on February 8th the sunspot area had been only 325 millionths.

The meridian passage of the largest group occurred on February 19th, a Sunday, but in accordance with previous experience the corresponding effects on the earth's atmosphere were not expected until about a day later. As early as February 16th, on the basis of the February 15th appearance of the sun, forecasters at the National Bureau of Standards issued warning of a blackout of short-wave radio communication expected to take place from February 20th to 22nd.

Outbursts of solar noise had occurred simultaneously with the appearance of the spot on February 13th, followed by other bursts on the 14th and 15th, the major solar noise on the 14th lasting over half an hour.

Brilliant flares of hydrogen light were expected to be associated with the large sunspot group. On February 20th, no flares were seen with the Naval Observatory spectrohelioscope at 9:15 a.m. At 10:30, the Bureau of Standards notified the observatory superintendent, Capt. G. W. Welker, of an ionospheric disturbance and the sun was re-examined. At 10:35, a brilliant flare was seen near the large group. The condensations in the flare were near sunspots, but shifted slightly from their positions. By 10:45 the intensity had diminished somewhat, dying out at 11:15, but another active center appeared nearby.

Monday night, at Washington, D. C., an aurora was seen lasting from 9:15 to 10:30 p.m. EST. Although not brilliant, it was noticed by observers working inside the domes of the 26-inch refractor and the 40-inch reflector at the Naval Observatory.

The aurora was much more conspicuous in New England. A detailed report has been received from William E. Meyer, Box 162 Wesleyan Station, Middletown, Conn. A patch of light near the zenith was at first mistaken for a cloud, until pulsation identified it definitely with the aurora. In the subsequent display diffuse patches, flickering areas, green and blue tints, and a drapery were all seen. The seeing was not good, but the transparency was excellent for photometric work that was being done at Van Vleck Observatory. By 11:15 p.m., the display had subsided. Mr. Meyer's roommate was having trouble with nearby stations on his radio, but was receiving unwanted far stations with exceptional clarity.

Aaron Liss, of 4811 N. Warnock St., Philadelphia 41, Pa., on February 18th made drawings of the spots on the sun with the aid of his 3½-inch refractor.

The sun, photographed at the U. S. Naval Observatory on February 11, 15, 19, and 23, 1950 (top to bottom). The large group, which was on the central meridian on the 19th, exceeded 100,000 miles in length. North is at the top, and east at the left.

Amateur Astronomers

NEWS OF CONVENTIONS AND MEETINGS AMONG AMATEURS

Middle East Convention At Norfolk

The Middle East region of the Astronomical League will convene at Norfolk, Va., May 5th to 7th. The program starts Friday evening, May 5th, at 8:30 p.m., with a welcome by P. N. Anderson, president of the Amateur Astronomers Society of Norfolk, host society, and an address, "Solar Radiation," by A. D. Hustead, of the Norfolk Weather Bureau Office. Starting at 9:30 p.m., the AAS of Norfolk will hold open house at its Lakeview Observatory.

Meetings will be held at the Norfolk Museum of Arts and Sciences. One large room has been assigned for exhibits, and it is hoped that all who attend will bring telescopes, telescopic equipment, and pictures and charts for display. Also invited are collections of society publicity, society publications, and materials for programing, meetings, picnics, and parties. There is no charge for exhibiting, and no prizes will be awarded.

Saturday morning at 8:30, there will be a meeting of the Middle East regional council, followed by the first business session, which convenes at 9:30 a.m., and includes a roll call of regional and visiting societies. Under the chairmanship of Charles Strull, Louisville Astronomical Society, papers on observing will be presented. The group photograph is scheduled for 11:40 a.m.

The league president, Charles H. LeRoy, of Pittsburgh's Amateur Astronomers Association, will make a report to the convention at 2:00 p.m. After the election of regional officers, Leo Schoenig, also of Pittsburgh, will preside over a session for papers on instrumentation and equipment. Gordon Urban, Pittsburgh junior member, will preside at a junior activities session with papers by juniors, beginning at 4:00.

There will be a banquet at Bell's Restaurant Saturday evening, followed by an address by Dr. James B. Edson, scientific consultant in the Office of the Chief of Ordnance, Washington, D. C. His topic will be "The Atmosphere of Venus," and will include a description of photographs of Venus taken by him as an amateur astronomer.

The Saturday evening program will conclude with a field trip to the Cape Henry Weather Bureau Ship Reporting Station at Fort Story, Va. Sunday, starting at 9:00 a.m., there will be a conducted tour of the historic Hampton Roads area.

Accommodations may be had at hotels, tourist homes, or motor courts. Among recommended downtown hotels near the museum are the Monticello, Thomas Nelson, and Atlantic. Hotel rates range from $3.00 to $5.00 for single room with bath, and $5.00 to $8.00 for double with bath. Reservations may be made directly or through A. D. Hustead, U. S. Weather Bureau Office, Norfolk, Va., who will also procure any reservations desired at tourist homes or motor courts. Requests for reservations should be mailed to reach Norfolk by April 15th.

The convention will welcome all amateur astronomers, and a special invitation is extended to those societies and their members in the southeastern United States.

G. R. WRIGHT, chairman
Middle East Region
830 Hemlock Court
Washington 12, D. C.

Western Conference At Palo Alto

August 14, 15, and 16, Monday through Wednesday, have been announced as the dates for the conference of western amateur astronomers at Palo Alto, of which announcement was made in the February issue, page 87. Dr. C. D. Shane, director of Lick Observatory, has informed the host group, the Peninsula Astronomical Society, that he will hold open house for the conference on the evening of the 16th.

The new address of H. A. Wallace, chairman of the Peninsula society's convention committee, is 2925A Jackson St., San Francisco 15, Calif.

Astronomical League Convention At Wellesley

A detailed account of program plans and reservation information for the 1950 Astronomical League convention, to be held on the Wellesley College campus on July 1-4, appeared in the March issue, page 112. Reservations from as many people as possible who are planning to attend should be sent **at once** to the convention chairman, Charles A. Federer, Jr. Reference should be made to last month's **Sky and Telescope** for full details.

AAVSO Spring Meeting At Penn State

The 39th annual spring meeting of the American Association of Variable Star Observers will be at Pennsylvania State College, in State College, Pa., on Friday and Saturday, May 5-6, 1950. The council will convene at 4:00 Friday afternoon, and that evening Dr. Henry L. Yeagley, associate professor of physics and director of the observatories at State College, will lecture on "Terrestrial and Extra-Terrestrial Influences on Bird Navigation." This lecture will be held in the Osmond Laboratory, where rooms will be open for a demonstration of telescope making workshops, the college planetarium, and other astronomical exhibits. The two student observatories will also be open if weather permits; these are located about half a mile from the Osmond Laboratory.

Saturday's program includes a morning session for business and the presentation of papers, luncheon at the Nittany Lion Inn, and an afternoon session for papers.

The Nittany Lion Inn, located on the college campus, and the Hotel State College, in the business section of the town but within walking distance of the meeting place, are holding blocks of rooms for AAVSO reservations up to and including April 29th. Amateurs expecting to attend the AAVSO spring meeting are urged to make their reservations early with either of these hotels, addressed at State College, Pa. There are two motels on Route 322, north and south of town.

Further information can be obtained from the recorder of the AAVSO, Mrs. Margaret W. Mayall, Harvard College Observatory, Cambridge 38, Mass.

North Central Regional Convention At Oshkosh

The North Central region of the Astronomical League will hold its convention on Friday and Saturday, April 14-15, at Oshkosh, Wis. Ralph N. Buckstaff, chairman of the region, will be host to the convention at his home and private observatory. This observatory is one of the best-equipped amateur installations in the country. League members and other amateur astronomers are invited to attend, and to communicate directly with Mr. Buckstaff, 1122 South Main St., Oshkosh, Wis., for further information concerning accommodations in the town. Papers on the convention program will be devoted principally to solar and variable star observations.

AMATEUR NEWS FROM HERE AND THERE

The **Beloit Amateur Telescope Makers Club** is meeting every other Thursday in the Rotary board room at the YMCA building, Beloit, Wis. President of the club is Dr. Kenneth E. Patterson, and the secretary-treasurer is Kenneth W. Schultz, of 959 Johnson St., Beloit. The club is planning to make variable star observations.

The Amateur Telescope Guild of the **Cincinnati Astronomical Association** is open to all persons interested in constructing a telescope. It meets every Monday evening in the basement of the Cincinnati Observatory, Mount Lookout, with a group of advanced amateurs serving as instructors. Late in December the guild sponsored a "planet gaze" at the observatory. Though the temperature was in the low 20's, about 300 people attended, and many remained until 1:30 a.m. to see Mars. Information on the guild may be had from E. Downey Funck, 2933 Boudinot Ave., Cincinnati 38, Ohio.

The **Greensboro Astronomy Club** has elected officers for 1950: Mrs. Z. V. Conyers, president; Dr. Ann Lewis, vice-president; Mrs. E. B. Swartze, secretary; H. M. Holliday, treasurer. Activities for the year are planned to include instruction, information, and pleasure. A program of regular observations is to be started. The Greensboro Astronomy Club has joined the Astronomical League.

The Buhl Planetarium is headquarters for the **Amateur Astronomers Association of Pittsburgh.** Every clear night the Buhl 10-inch siderostat telescope is operated by a member of the society's telescope committee, who describes the celestial object that the visitors are observing and answers questions concerning it.

The **Pontiac Amateur Astronomers Association** has received a gift of 1½ acres

of land from Elvan N. Smith. It is located inside the limits of the city of Pontiac, at an elevation of 940 feet.

The **Port Arthur Astronomy Club**, in Texas, has been recently organized. Stimulated by the appearance of Comet 1948l, Gerrit van den Berg through his local paper, the Port Arthur **News**, sent out a call to everyone who might be interested in forming an astronomy club. At its first meeting, the following equipment was at the disposal of the interested persons present: a 3½-inch reflector, a 2½-inch refractor, 15 x 50 binoculars, a 27-power hand telescope. There followed several open meetings and a couple of demonstrations for boy scouts with the aid of a hurriedly built 5-inch reflector. An observing party was held for the October lunar eclipse.

A current project is a more substantial, equatorially mounted reflector. The Port Arthur group has become a member of the Astronomical League. Further information can be obtained from Mr. van den Berg, at Box 266, Groves, Jefferson County, Tex.

A new departure in the **Sacramento Valley Astronomical Society** is a monthly discussion group within the society by members interested in serious study. The leader of the April 10th meeting of the discussion group is Carl W. Anderson, at 7:45 p.m., at Sacramento Junior College.

The **Schenectady Astronomy Club** held its annual banquet on February 13th at Hale House, Union College, with 40 persons in attendance. Professor E. S. C. Smith, chairman of geology at Union College, spoke on "Meteors and Meteor Craters." C. E. Johnson, president of the group, was toastmaster.

Under the direction of George Staffa, the club is repairing some telescopes, and is ready to initiate a new Schmidt telescope. The club is also sponsoring a junior group in astronomy at the Schenectady Boys Club.

The **St. Louis Amateur Astronomical Society**, with 32 members, has voted to join the Astronomical League. Stuart L. O'Byrne, 501 E. Pacific Ave., Webster Groves 19, Mo., is president of the society.

At the meeting of the **Stamford Amateur Astronomers** in February, new officers were elected as follows: Chairman, Edwin M. Bailey, Jr.; vice-chairman, Alan F. Kirkpatrick; secretary, Thomas J. Page. Mr. Page can be addressed at 52 Frank St., Stamford, Conn.

BUFFALO AMATEUR DIES

On January 11, 1950, James H. McArtney, president of the Amateur Telescope Makers and Observers of Buffalo, died of a sudden heart attack. Active in its reorganization after the war, he was elected president of the society for five consecutive years. He was a tireless leader in local astronomical activities, demonstrating the Spitz planetarium at the Buffalo Museum of Science, acting as instructor for the telescope making classes, and continually working toward increasing the scope and membership of the Buffalo society. His loss is a great one to astronomy in western New York.

THIS MONTH'S MEETINGS

Atlanta, Ga.: At the April 14th meeting of the Atlanta Astronomers in Science Hall of Agnes Scott College, Decatur, at 8 p.m., H. E. Bussey will speak on "Invisible Planetary Systems."

Cambridge, Mass.: On the 13th of April, at a joint meeting of the Amateur Telescope Makers of Boston and the Bond Astronomical Club, Dr. Donald H. Menzel, of Harvard College Observatory, will speak on "Action on the Sun." There will be a showing of the latest prominence motion pictures obtained with the coronagraph at the High Altitude Observatory in Colorado. The meeting is at 8:15 p.m., in the Harvard Observatory library.

Chicago, Ill.: The Burnham Astronomical Society will meet April 11th, at 8 p.m. in the Chicago Academy of Sciences auditorium. H. C. Torreyson will speak on "Telescopes for Special Purposes," and Donald Pass will speak on "Astronomy as a Career."

Cleveland, Ohio: Leslie C. Peltier, of Delphos, Ohio, will speak at the meeting of the Cleveland Astronomical Society on April 7th, 8 p.m. at the Warner and Swasey Observatory. Mr. Peltier's subject will be "The Amateur Astronomer."

Dallas, Tex.: On Monday, April 24th, the Texas Astronomical Society will hold a field meeting, near the Cedar Crest Country Club. Several members will provide telescopes, and will lecture on constellations, planets, variable and double stars. The public is invited.

Detroit, Mich.: The Detroit Astronomical Society will meet on Sunday, April 16th, in State Hall, Wayne University, at 3 p.m. Dr. Orren C. Mohler, McMath-Hulbert Observatory, will speak on "Solar Fields of Force."

Geneva, Ill.: At the Tuesday, April 4th, meeting of the Fox Valley Astronomical Society, 8 p.m. in the Geneva City Hall, Frank Hancock will speak on "Volcanoes and Their Phenomena." The society will hold its annual banquet, also in the City Hall, on Saturday, April 22nd. Dr. K. Aa. Strand, of Dearborn Observatory, will be guest speaker, and his topic is "Weighing the Stars."

Indianapolis, Ind.: Dr. Frank K. Edmondson, of Indiana University, will discuss "Our Universe" at the April 2nd meeting of the Indiana Astronomical Society, at 2:15 p.m. in Cropsey Hall.

Kalamazoo, Mich.: On Saturday, April 22nd, the Kalamazoo Amateur Astronomical Association will meet at the home of Dr. and Mrs. L. N. Upjohn, 1556 Long Road. Dr. Upjohn will speak on "High Tides in Astronomy."

New York, N. Y.: Dr. George Gamow, of George Washington University, will address the Amateur Astronomers Association meeting on April 5th, speaking on "Creation and Evolution of the Universe." The meeting is in the American Museum of Natural History (77th St. entrance) at 8 o'clock.

Oakland, Calif.: Leon Salanave, Sacramento College Observatory, will speak at the April 1st meeting of the Eastbay Astronomical Society, on "New Light on the Moon, or Recent Developments in the Meteoric Theory of Lunar Craters," at 8 p.m. at Chabot Observatory. Observing with the 8- and 20-inch telescopes will precede and follow the lecture, weather permitting.

Sacramento, Calif.: The Sacramento Valley Astronomical Society is sponsoring a series of public lectures, the fourth of which will be on April 4th, at Sacramento Junior College. Dr. N. U. Mayall, of Lick Observatory, will speak on "Galaxies."

St. Paul, Minn.: Dr. L. W. Sheriden, of St. Thomas College, will address the St. Paul Telescope Club at 8:00 p.m., Wednesday, April 26th, at Carnegie Science Hall, Macalester College. His subject will be "The Earth's Atmosphere."

San Diego, Calif.: The San Diego Astronomical Society will have a membership evening on April 7th at 7:30 p.m., in room 504 of the Gas and Electric Building. Short talks on science and astronomy will be given by the members, assisted by Prof. B. O. Lacey. Prof. W. T. Skilling will give a resume of the program.

Washington, D. C.: The National Capital Astronomers will meet on Saturday, April 1st, at 8:00 p.m. at the Commerce Building auditorium. Ernest G. Reuning, of the U. S. Naval Observatory, will speak on "The History of Astronomy — a Projection of its Application in the Future."

PUBLIC NIGHTS AT LINK OBSERVATORY

A series of public nights to be held at Goethe Link Observatory, Brooklyn, Ind., has been announced by the astronomy department of Indiana University, Bloomington, from which free tickets may be obtained in exchange for a self-addressed stamped envelope. The observatory will be open from 7 until 9 p.m., and the lecture will be given at 7:30 and repeated at 8:30. In requesting tickets, please specify whether for the first or second lecture.

On April 30th, Dr. John B. Irwin will speak on "Variable Stars," and the observing object is Saturn. "Star Clusters" will be discussed on May 14th by Arthur N. Cox, while the cluster M3 is observed. On May 28th telescopes will be trained on the moon, and motion pictures on "Solar Prominences" will be shown.

J. M. SHOWALTER DIES

The Burnham Astronomical Society has lost its leading member and president, James Madison Showalter, who died suddenly of a heart attack at his home in Van Wert, Ohio, on Saturday, February 25th. Mr. Showalter was under doctor's orders, and had gone to his Ohio home to rest. Shortly before his death he expressed his regret at missing recent meetings of the society and his hope to get back to Chicago soon.

Late in 1944, Mr. Showalter called for a reorganization meeting of the Burnham Astronomical Society, and it was decided to incorporate and to become affiliated with the Chicago Academy of Sciences. Since then, under Mr. Showalter's able leadership, the Burnham society has grown to its present stature.

BOOKS AND THE SKY

NAVIGATION THE EASY WAY

Carl D. Lane and **John Montgomery.** W. W. Norton and Company, Inc., New York, 1949. 126 pages. $2.95.

IN ADDRESSING the reader at the beginning of this book, the authors state their belief that anybody can navigate. "There is no hocus-pocus about navigation; no magic formulas; no midnight wizardry. The only arithmetic required is simple, grade-school addition and subtraction — and not much of that."

This might have been a suitable book for the layman who has merely a general interest in the subject. **Navigation the Easy Way** can easily be read in one evening, and its great simplicity, the chief point emphasized by the authors, will quickly acquaint the reader with a few of the basic principles of navigation. But there are too many careless errors and fallacies, and the course of simplicity, as it is charted, has many serious and hidden dangers for the sailor, yachtsman, or aviator who would try to learn navigation from this book.

In the first place, the authors advise against rules — even rules of thumb. Instead, they advocate the drawing of diagrams, "to see the problems," and they proceed to reproduce many time diagrams. The importance of time diagrams cannot be overemphasized, but if some rules had been used to check the drawings perhaps many mistakes, such as those in the lower middle diagram on page 56, would have been avoided. These mistakes could be most unfortunate for a future navigator.

Dangerous, secondly, is the inaccurate construction of many of the angles in the diagrams. The numerous errors cannot all be mentioned here, but especially bad is the lower figure on page 55 and the figure on page 89. Even without a protractor, an angle of 270° should be visualized as three quarters of a circle, and an angle of 276° as somewhat larger than three quarters of a circle. Similarly, 188° is more, not less, than a straight angle of 180°.

As early as pages 5 and 6, the reciprocal of a bearing of 75° is given as 285°, and used four times that way and labeled as such in the diagram. The authors themselves should have visualized 285° as a true bearing that could not possibly lie in a southwesterly direction. **Accuracy** must be coupled with good navigation, and if the authors had emphasized accuracy as well as simplicity, their book would have been valuable.

Other errors are: On page 69, the light ray is bent upward, instead of downward, by refraction in the atmosphere; from this illustration the reader would never understand why the correction is always subtracted. The speed of radio waves on page 106 is given as 780,000 miles a second. On page 95, the reader might receive an erroneous impression of the declination of a star and of its degree of constancy during the year.

Notable omissions include the corrections necessary in connection with noon sights to take care of the speed of an airplane or a fast ship; further drawings and explanations of "when you are North or South of the sun"; further instruction in the drawing of time diagrams, including both upper and lower branches of the meridian.

Often **one** mathematician, with the aid of computing machines, has made up navigation tables; it rarely takes "countless mathematicians," as indicated on page 61; and it might be well to make the layman feel that he too is capable of such mathematical solutions.

Altogether, this little book is fraught with dangers for a navigator, but a carefully corrected second printing might produce a valuable volume for the layman who desires a one-lesson understanding of the principles of navigation.

Carl D. Lane is also author of **How to Sail** and **The Boatman's Manual,** and John Montgomery was a teacher of navigation in the latest war.

FRANCES W. WRIGHT
Harvard College Observatory

STORIA DELL' ASTRONOMIA

Giorgio Abetti. Vallecchi, Florence, Italy, 1949. 370 pages. Price not given.

DR. ABETTI, the leading astronomer of Italy, is well known to popular readers for his book on the sun. The history of astronomy reviewed here, written in Italian, is a well-balanced account of the development of the first of the

sciences. He discusses in turn ancient, medieval, and Renaissance astronomy, and the development of the science up to the birth of astrophysics. The second half of the book considers 19th- and 20th-century astronomy. The treatment is popular, and necessarily brief.

A bare outline of the scope of the book does not, however, do justice to its merits. Dr. Abetti is director of the observatory at Arcetri, the very spot where Galileo worked, and Galileo has always been one of his especial concerns. His account of Galileo's work is one of the most interesting sections of the book. But the feature that gives Dr. Abetti's history its particular quality is the excellent series of illustrations, many of them not available elsewhere — Galileo's first lens, his house, a portrait rarely reproduced, pages from his notebooks; and other pictures relating to historic investigators and instruments in Italy. For the illustrations alone the book is worth possessing.

Astronomers will find the appendix of great service. Here we have a survey of the astronomical observatories of Italy, with discussion of their history, equipment, and current problems. There is also a valuable account of the International Astronomical Union, in whose counsels Dr. Abetti has always taken a prominent part.

Storia dell' Astronomia is primarily written for the popular reader in Italy. But its scope, authoritative treatment, and readability should commend it to a wider circle of readers.

CECILIA PAYNE-GAPOSCHKIN
Harvard College Observatory

NEW BOOKS RECEIVED

SOME EARLY TOOLS OF AMERICAN SCIENCE, *I. Bernard Cohen*, 1950, *Harvard University Press*. 201 pages. $4.75.

From source materials on early collections of scientific instruments at Harvard, the author develops the story of teaching and research in colonial New England, and brings out how important a part science played in the culture of America of that period.

IN STARRY SKIES and BEAUTIES OF EARTH AND SKY, *Sterling Bunch*, undated, *Mrs. Pearl P. Bunch*, Springtown, Tex. 48 pages, $2.00.

A collection of poems by the late Sterling Bunch, meteorologist and amateur astronomer. The first section is of poems with astronomical themes, and the second contains poems on nature and miscellaneous subjects. This book may be ordered directly from the author's mother, who compiled the poems in their present form.

RELATIVITY — A RICHER TRUTH, *Philipp Frank*, 1950, *Beacon Press*. 142 pages. $2.00.

A volume of the Seeds of Thought series, discussing the moral, ethical, and political implications of modern science. The author, a well-known Harvard physicist and philosopher, stresses the use and misuse to which Einstein's theory of relativity has been put in the field of ethical values.

THE EXPLANATION OF LIFE, *Stephen Th. Bornemisza*, 1949, *Rascher Publishing House*, Zurich. 272 pages. Price not given.

An attempt to explain on ordinary physical principles the operation of natural processes that produce life and mind, with the postulation of two divergent components, structural changes and recurrent changes.

GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

A Report from New Zealand

MY INTEREST in telescopes began some 10 years ago and, after trying my hand at a 6-inch reflector which was anything but good, I turned my attention to refractors. A start was made with 2½-inch disks, and armed with **ATM** and **ATMA** a fair telescope was the result, using an upright spindle for both grinding and polishing.

From there I progressed through 3-inch and 4-inch sizes and finally to a 6-inch at f/12. This lens was reground twice before I was satisfied with the color correction and definition, as the only optical glass available here during the war was purchased from Australia, already molded for an f/5 objective, with the indices a bit off the astronomical standards.

I used a perhaps rather crude method in figuring the lens, but it was simple and quite effective. The two components were edged by revolving each lens slowly on a horizontal spindle, its edge passing between the jaws of an Ames dial micrometer which in turn was mounted on a wood block, and centering the lens until no movement was noticeable on the micrometer dial. Then the two inside surfaces were polished carefully, shaping the HCF lap so as to bring the whole surface to a complete polish as evenly as possible.

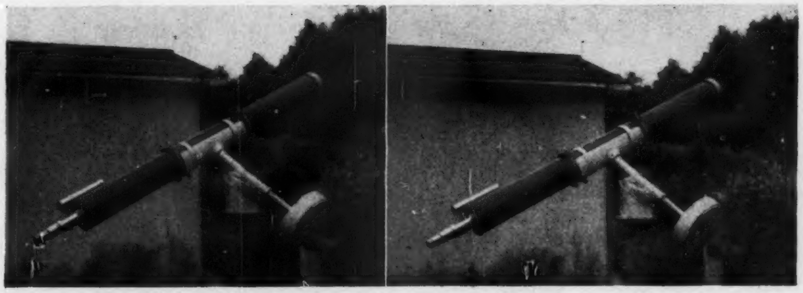
These surfaces were then heated slowly and hard-cemented with balsam; this is a tricky operation as there always seem to be a few small air bubbles that will not come to the edge. The assembly was then treated as one lens as the inside surfaces were canceled by the balsam. The lenses were left rather thick after the grinding (flint one inch, crown one-half inch at the edge); edging was done Porter style.

The outside surfaces were then partly polished, and the lens set up in the tube with a 1-inch eyepiece and focused on an old-type "Z" filament electric lamp parked 25 yards or so away. On a dull day or at night the glowing filament can be easily seen and the "before and after focus" colors noted. The fourth surface of the objective (easiest to work as nearly plano) was then ground slightly plus or minus to bring the color to what was desired. On this 6-inch lens, best results astronomically were with mauve before and yellow-green after the focus, indicating that slight overcorrection is desirable.

For the actual figuring a number of 6-inch cardboard disks were cut that fitted neatly in the cell against the objective. These were pierced in the center with apertures of from one to five inches. The cutout pieces were saved and numbered 1 to 5, as were the first disks. With the first and fourth surfaces completely polished, through use of these disks any part, or ring of glass, could be tested by direct viewing of an object, such as very small printing fixed to a pole about 40 feet away. The focus was marked on a small card fixed to the testing rack. For example, for the zone next to the center, a 1-inch disk was held in place in the center of the lens by a small blob of wax and a 6-inch disk with a 2-inch hole was placed in the cell, thus leaving a ring of clear glass one inch wide.

The first polishings were done with red rouge, but this was superseded by cerium oxide as soon as that became available in New Zealand, which was only during

Photos from New Zealand that show (top to bottom) the home workshop and 6-inch refractor mounting of B. A. Holmes; the workshop interior, smallest grinding machine on table, larger machine in center, and surfacing machine in background; a closeup of the surfacing machine and prism cutter; 17 x 85 binoculars in the making.



A stereoscopic pair of pictures of the author's home-made 6-inch refractor.

1948. Although it is a bit inclined to chatter at first, cerium is quick and clean, which makes it popular here and elsewhere.

As I live on a dairy farm there is plenty of room to place gadgets on posts and sheds, but we have very heavy dew at times, which wets one's apparatus and telescopes in a very short time. Therefore, I have rigged up electric artificial stars controlled from indoors, and have replaced some windows with good plate glass. This makes some inside tests possible, and comfortable in colder weather. For figuring lenses at night, a shutter with a 6-inch hole replaces even the plate glass, which is not optically flat, but for color correcting, focusing, and the like, it will pass light satisfactorily.

The 6-inch refractor mounting is made of steel plate, piping, cream separator and aircraft parts, all bolted to an aircraft wheel ram, which can be pumped up another two feet for those hard-to-reach zenith stars. A propeller ball race (6-inch) takes the polar axis weight, with clutch, worm drive, and a small thrust race all inside the mount. The declination axis is a 1-inch shaft through a 12-inch white-metal bearing run in a pipe, the whole assembly working very smoothly. The hand control is connected with a 3-inch coupling of speedometer cable, which is very flexible.

Milking-machine plated brass piping is used for the drawtube, finder, and the like, and other machine brassware for the cell and eye end. This gear is usually readily available here in the Waikato.

It is intended to house this telescope in a Hartness turret as soon as the time can be found, using an English Perspex aircraft gun turret having a 4-foot ball-bearing gear-driven rim and several other useful parts.

We have nothing like the wide variety of war surplus optics available in your country, but I have picked up a few items at war assets sales from time to time. The dollar situation means now that there is little chance of obtaining anything from the United States, so one can but cast wistful glances at the war surplus items in your magazine.

I secured from Australia a short time ago two large elbow telescopes, each with a 2-inch objective, and after much sawing and filing evolved a beautiful pair of binoculars. Their field is wide and with amazing definition and brilliance. Some time ago, **Scientific American** described a very large binocular made from war sur-

GLEANINGS is always ready to receive reports and pictures of amateur instruments and devices, and is open for comment, contributions, and questions from its readers.

A lunch-hour gathering of some of the Hamilton Astronomical Society's members, with their 14-inch Ward reflector. It is mounted in Mr. Roberts' garden; he has his hand on the front of the tube. Allan Bryce, then president of the society, is at the extreme right.

plus optics, and I have tried my hand at this. The binocular is now almost finished, the metal work being of soldered sheet brass. The power is 17x, with f/5 3¼-inch objectives. One of these has still to be polished and figured, but the result should be interesting when the 17 x 85 instrument is completed. This instrument is shown in the lowest picture of the four on page 144.

The Hamilton Astronomical Society is quite active, and I enclose several photographs illustrating things mentioned in this letter.

B. A. HOLMES
5 Victoria Arcade
Hamilton, New Zealand

"RATHER HEATH ROBINSON"

Enclosed is a photograph of an 8-inch reflector I constructed during the war, rather Heath Robinson; do you know what that means, in the States? The mount has obvious faults, however it works very well. A truck wheel and brake drum form a rough equatorial.

DR. W. E. HARRIS
Middleton St., Llandrindod Wells
Radnor, Wales

OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Visual Observing Programs for Amateurs

IT IS ESTIMATED that 30,000 amateurs have made their own telescopes, but that only 300 amateurs are engaged in any systematic program of observation, in which their results are carefully recorded and submitted for study to scientific bodies.

Probably the fact that most of us have a deep urge to make things with our hands is primarily responsible for this ratio of 100 to 1. However, it may be caused in part by the misconception that visual observations with small instruments are outmoded. It may also be caused by the fact that thousands of pages of instructions on how to make telescopes have been published in the last 25 years, but probably not more than a few hundred pages which describe the use of telescopes for visual observers.

Therefore, this is the first in a series of articles devoted to removing the above misconception and to giving instructions in visual observing. The need for visual observations by amateurs will probably increase as professional astronomers find more objects in the sky which require watching. The advantage of visual work is that it can be easily and quickly done without spending the money or time required to take photographs and study them afterwards.

At present, visual observations by amateurs are of value on variable stars; novae; occultations of stars and planets by the moon; sunspot counting; manifestations of sudden increases in solar activity; the foreshortening of sunspots; the granulation of the sun's surface; the presence of E-type groups in the sun's center zone; auroral statistics; migratory birds crossing the sun or moon; lunar and planetary details; the varying brightnesses of planets and some asteroids; telescopic meteors; the search for meteors hitting the moon; meteor counting; the zodiacal light; halos; and probably other phenomena of which the writer has no knowledge. I have been assured that many of these lines of visual research must be carried forward for a century or more, if for no other reason than to derive the full advantages of the work which has already been done on them in past decades.

Actually, of course, new problems are continually presenting themselves. Professional astronomers are now not only concerned with the variations but with the "variations in the variations" of variable stars. Judging the future from the past, a century is too short a time in which to secure the data to solve such problems. The American Association of Variable Star Observers now has charts on Luyten's newly discovered "flame star" in Cetus and two others in Aquarius and Leo. These vary so rapidly and unexpectedly that it will take at least a portion of the observing time of each of a score of the AAVSO observers to follow these stars as they must be followed before their visual light curves can be determined. The coronagraph and other new devices have made it possible to study the sun in more detail than before. It is therefore more important than formerly for professional astronomers to know when any sudden activity occurs on the sun. The members of the Solar Division of the AAVSO have taken on this duty as "watch dogs of the sun." (This does not make us sundogs!)

The above examples are typical of the new lines of study which are continually opening before the eyes of amateurs.

Thus it is evident that visual observations with small telescopes are not outmoded. Let us turn to the questions of the observing equipment needed for visual work, the methods of locating objects under study, the kinds of observations needed, and the reports required. To cover this ground will take a number of articles.

Instruments

The eye, binoculars, and visual telescopes will be our tools for Operation Amateur. It will be of the most immediate use to our readers if we make a number of general statements now and illustrate these generalities later by descriptions of individual instruments and the purposes for which they are used.

1. There is no universal telescope which is equally good for all purposes; a binocular will do some things a 3-inch telescope cannot, and vice versa; they are not interchangeable.

2. Every telescope represents a compromise in which some desirable feature has been sacrificed to secure some other advantage.

3. In general, the observing amateur will find that the optics of telescopes which come into his hands are good but that mechanically the telescopes are inconvenient to use and are shakily made, and that they have to be much improved after use has shown up the weak points in the design.

4. An instrument which is not convenient to use will not be used. (I wish that it were possible to state the reverse, "An instrument which is convenient to use will be used," but perhaps these discussions will help encourage that situation.)

5. Don't get bitten by the "bigness bug." Most amateurs have to use portable instruments. Four-inch refractors and 6-inch reflectors are the absolute upper limit of portability.

6. Every telescope of above 15 power, or 15x as it is commonly stated, should have a finder.

7. Equatorial mountings and setting circles are unnecessary for the amateur. For work on Mars and Saturn, however, a pier, clock drive, and slow motions are decided conveniences.

8. Every telescope above 15x should be mounted. The mounting should be so made that when one removes his hand after pointing it the telescope does not fall away from the star, but remains pointing at the star. This is practically the only real requirement for the mounting of a visual telescope. Unaligned equatorial-

type mountings or fork-type mountings can provide this feature. Exact balancing of the telescope about the axes and the elimination of all lost motion in the focusing device are required.

9. A wooden tripod mounting is steady enough for 6-inch telescopes, with powers up to about 150x, which suffice for all but close double star work and planets other than Jupiter.

10. Use low powers wherever possible. The lower the power the wider the field, and the greater the steadiness of the image. For variable stars the writer uses 40x, 25x, a 10x finder, the naked eye, and 75x, in about that order. Probably about 80 per cent of my observations are made with 40x, five per cent with 25x, and the remaining 15 per cent are made with the other powers. For the sun, I find the atmosphere too unsteady to use more than 40x or 50x, but others use up to about 60x. Planets require 100x for Jupiter and 200x or 300x for the others; the same powers are useful on the moon.

D. W. ROSEBRUGH
87 Fern Circle
Waterbury 8, Conn.

OCCULTATION PREDICTIONS

On the evening of April 19th, observers in the Southwest and on the West Coast should watch the three-day-old crescent moon in the western sky, for it will be passing among the stars of the Pleiades, as the accompanying predictions for stations H and I show. Careful observations with a telescope should begin immediately after sunset (or before), for the star Merope (23 Tauri) will be occulted at station H at about one minute before 7:00 p.m. Pacific standard time. Three quarters of an hour later Alcyone (Eta Tauri) will be hidden, and at 8:00 p.m. Merope will come out of hiding, followed 24 minutes later by Alcyone. At station I, an occultation is predicted for the star Atlas (27 Tauri), a double.

Thirteen stars of the Pleiades cluster are listed on April 19th in the elements for the prediction of occultations in the **American Ephemeris and Nautical Almanac.** The latitude limits given for these indicate that most of the 13 possible occultations would be visible only to the south of the United States.

It is important for each observer to realize that for his local point of observation the times of immersion and emersion may differ materially from those computed from the **a** and **b** quantities given below, especially if he is located several hundred miles from one of the standard stations. Also, in some of the most favorable observing areas, such as the southeastern United States, there are no official local predictions available at all, but an estimate of what to expect can be made by studying the predictions for the standard stations. Serious observers who wish to make their own predictions should consult the **American Ephemeris.**

The rather unfavorable occultation of Spica on April 30th is the last important event until August. During most of May, and in June and July, there are no occultations of significance for stars brighter than 5.0 for American observers. Occultation listings will be omitted until the August issue.

April 19-20 **23 Tauri** 4.2, 3:43.4 +23-47.6, 3, Im: **H** 2:58.9 —0.6 —0.4 66. Em: **H** 4:00.2 +0.2 —1.5 279.

April 19-20 **Eta Tauri** 3.0, 3:44.5 +23-57.1, 3, Im: **H** 3:46.7 —0.9 +1.0 31. Em: **H** 4:24.0 +1.0 —2.9 315.

April 19-20 **27 Tauri m** 3.8, 3:46.2 +23-54.1, 3, Im: **I** 4:27.5 ... ... 10.

April 22-23 **49 Aurigae** 5.0, 6:32.1 +28-03.8, 6, Im: **H** 6:57.3 —0.2 —0.4 59. Em: **H** 7:36.7 +1.0 —2.0 325.

April 27-28 **Chi Leonis** 4.7, 11:02.4 +7-36.4, 11, Im: **G** 8:22.9 —0.8 —1.5 81; **H** 8:40.5 —0.7 —1.4 105; **I** 8:16.9 —1.0 —1.5 93. Em: **H** 9:38.2 —0.1 —2.0 322.

April 28-29 **Beta Virginis** 3.8, 11:48.1 +2-02.8, 12, Im: **H** 4:31.9 —2.6 +0.4 91. Em: **H** 5:28.9 —0.3 —2.6 353.

April 30-May 1 **Alpha Virginis** 1.2, 13:22.6 —10-54.1, 14, Im: **A** 23:15.5 ... ... 192. Em: **A** 23:37.0 ... ... 234; **B** 23:44.7 —1.1 +2.3 253.

May 2-3 **A Scorpii** 4.8, 15:50.6 —25-10.8, 16, Im: **H** 12:42.7 —0.9 —0.6 71. Em: **H** 13:40.0 —1.0 —2.0 308.

May 4-5 **W Sagittarii** 4.3-5.1, 18:01.8 —29-35.1, 18, Im: **F** 12:30.1 ... ... 146; **H** 11:29.0 —2.2 —0.5 107. Em: **F** 12:59.7 ... ... 195; **H** 12:45.5 —1.7 —0.1 247.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the American Ephemeris and the British Nautical Almanac are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computations of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A +72°.5, +42°.5	**E** +91°.0, +40°.0
B +73°.6, +45°.6	**F** +98°.0, +30°.0
C +77°.1, +38°.9	**G** +114°.0, +50°.9
D +79°.4, +43°.7	**H** +120°.0, +36°.0
I +123°.1, +49°.5	

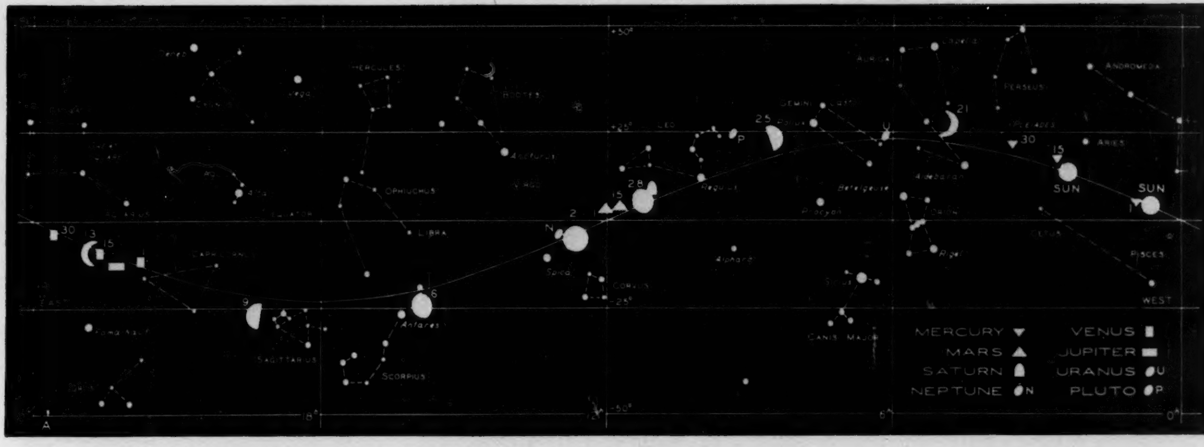
PREDICTIONS OF BRIGHT ASTEROID POSITIONS

No. 2	**Pallas**		Mag. 8.2	
	h	m	°	′
April 19	15	35.6	+21	25
April 29	15	28.4	+23	33
May 9	15	20.2	+25	07
May 19	15	11.9	+26	03
May 29	15	4.4	+26	22
June 8	14	58.5	+26	07

The above are predicted positions in right ascension and declination for the epoch 1950.0, for 0^h Universal time. The magnitude is that expected at opposition. In each case the motion of the asteroid is retrograde.

METEORS IN APRIL

The Lyrids, a rather poor shower, come to maximum on April 21st, and conditions are favorable for observing them. Rates are from five to 10 per hour after midnight. The radiant is about 10° southwest of Vega, and the Lyrids are seen as swift streaks.



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

The middle of April presents all five naked-eye planets for easy observation: Mercury, Saturn, and Mars after sunset; Venus and Jupiter before sunrise. Uranus, Neptune, and Pluto are also in the night sky, and only the last is too faint for identification by amateur observers.

Mercury will be well situated for observing in the evening sky most of the month. The most favorable elongation this year occurs on April 23rd, when Mercury will be 20° 13′ east of the sun, setting 1¾ hours after sunset. Keen-eyed observers may detect Mercury as early as April 4th or 5th, the planet setting half an hour after the sun but of magnitude −1.4. At elongation the brightness will have decreased to +0.4, but the planet will remain observable until May.

Venus reaches greatest elongation on April 11th, 46° 21′ west of the sun. The planet will be conspicuous at magnitude −4.0, rising two hours before the sun. Telescopically, it appears at the quarter phase, and 25″ in diameter. After this, Venus will recede toward the sun, taking seven months for the journey.

The moon. A total lunar eclipse takes place on April 2nd, invisible from North America (see the March issue). The ascending node of the moon is now 6° east of the vernal equinox, and will reach it in August. In mid-northern latitudes, the last-quarter moon rises 1¾ hours after midnight and first-quarter setting is 1½ hours past midnight.

Mars is favorably placed in western Virgo, transiting during evening hours. It passed opposition on March 23rd and remains bright, at magnitude −1.0 to −0.5; it presents a disk of 13″.7 on the 15th. A conjunction with the moon takes place on the 28th, at 22:55 UT, with Mars 46′ geocentrically north of the moon's center.

Jupiter, in Aquarius, rises before morning twilight. On April 5th at 11^h Venus and Jupiter are in conjunction, Venus 2° 19′ north. Some mutual occultations of Jupiter's satellites occur this month, as discussed on page 150.

Saturn is prominent in Leo, on the meridian after sunset. The planet continues in retrograde motion about 1° north of Chi Leonis. The moon and Saturn will be in close proximity on April 28th, conjunction occurring at 6:42 UT, with the planet geocentrically 1′ north; this is an occultation in South Africa. Saturn's rings are inclined about 4½° this month.

Uranus is moving eastward in Gemini, as shown on the chart in the February issue. It sets before midnight.

Neptune comes to opposition with the sun on April 6th. It is about 2° west of Theta Virginis and in retrograde motion; the magnitude is +7.7.

Pluto is in Leo, midway between Lambda and Kappa Leonis. Its present retrograde motion ceases at the end of the month. On April 29th its position will be $9^h\ 23^m\ 31^s$, +23° 55′ 39″. Its distance from the earth then will be about 36.1 astronomical units.

E. O.

VARIABLE STAR MAXIMA

April 7, S Gruis, 7.8, 2219**48**; 8, RT Cygni, 7.4, 194048; 11, S Herculis, 7.6, 164715; 12, R Ophiuchi, 7.6, 1702**15**; 12, U Cygni, 7.6, 201647; 13, RT Hydrae, 7.6, 082**405**; 18, R Cancri, 6.8, 081112; 21, T Centauri, 6.1, 133633; 23, RS Librae, 7.7, 1518**22**; 29, R Sagittarii, 7.2, 1910**19**; 30, V Coronae Borealis, 7.4, 154639. May 3, R Canum Venaticorum, 7.7, 134440; 8, RR Scorpii, 6.0, 1650**30a**.

These predictions of variable star maxima are by Leon Campbell, honorary recorder of the AAVSO. Only stars are included whose mean maximum magnitudes, as recently deduced from a discussion of nearly 400 long-period variables, are brighter than magnitude 8.0. Some of these stars, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

MINIMA OF ALGOL

April 3, 14:16; 6, 11:05; 9, 7:54; 12, 4:43; 15, 1:32; 17, 22:21; 20, 19:10; 23, 16:00; 26, 12:49; 29, 9:38. May 2, 6:27; 5, 3:16.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See Sky and Telescope, Vol. VII, page 260, August, 1948, for further explanation.

SKY-GAZERS EXCHANGE

Planetarium Notes

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evenings, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: *Little Planetarium.* Boston Museum of Science, Science Park, Boston 15, Mass. Richmond 2-1410.

SCHEDULE: Tuesday thru Friday at 3:30 p.m.; Saturday, 2:00 and 3:30 p.m.; Sunday, 3 and 4 p.m. Spitz projector. In charge, Charles A. Federer, Jr.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Director, Roy K. Marshall.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P.O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m. Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NEW YORK CITY: *Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Endicott 2-8500.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Curator, Gordon A. Atwater.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:15 p.m. Special showings on request. Admission free. Spitz projector. Director, Robert E. Cox.

MUTUAL PHENOMENA OF JUPITER'S SATELLITES

DURING April the earth is near the plane of the orbits of Jupiter's bright satellites. This makes possible mutual occultations of the satellites, one by the other. The **Handbook** of the British Astronomical Association contains predictions of **I** by **II**, prepared by D. A. Appleby and K. Pollock.

Of 15 occultations of **I** by **II** that occur during April, only three take place at times possibly favorable to observers somewhere in the United States. This is because Jupiter rises only 1½-2 hours before the sun at the beginning of the month and about 2½-3 hours at the end of the month.

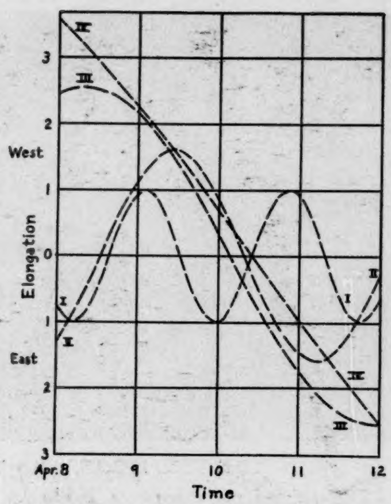
On April 15th, from 3:12 to 3:25 a.m. EST, just about when Jupiter is rising at Boston, satellite **II** will cover **I**. On the 22nd, from 5:20 to 5:38 a.m. CST, another occultation occurs, about at sunrise in the Middle West, but during twilight in the Mountain time zone, and when Jupiter is rising along the West Coast. On April 30th, eastern observers are favored by an occultation lasting from 3:18 to 3:26 EST.

Walter H. Haas, director of the Association of Lunar and Planetary Observers, points out that these phenomena are naturally most effectively observed with large telescopes. Rather high magnifications should be used in order to show the disks of the satellites as well as possible, at least 200x on a 6-inch telescope and 300x on a 10-inch. Since the disks of the satellites are enlarged by irradiation, poor seeing, and the like, it will be well to start watching them at least 20 minutes before the predicted beginning times. From the same cause the observed intervals of occultation may be longer than predicted.

As for mutual eclipses of the Jovian satellites, these are bound to occur when the sun lies in the plane of the planet's equator and of the four bright satellites. This happened while Jupiter was invisible near the sun early in the year, and as seen from Jupiter the angle between the sun and this plane is about ¼° in the middle of April. It gradually increases and exceeds 1° in October (see page 406, 1950 **American Ephemeris**).

By reason of this slight and increasing angle, the shadow of one satellite, extending hundreds of thousands of miles to the orbit of another satellite, may pass above or below the second satellite or may cause only a weak partial eclipse. Another unfavorable factor, always present, is that the shadows are cones, on the order of a million miles long for **II**, and longer for the others in proportion to their diameters. These are given as 2,300, 2,000, 3,200, and 3,200, for **I**, **II**, **III**, and **IV**, in the 1950 **Observer's Handbook** of the Royal Astronomical Society of Canada. Thus, the cone-shaped shadow of such a satellite as **II** can produce only an annular or partial eclipse when it falls on another satellite, and this is true in large measure for the other satellites as well. The orbit radii are, respectively, 261,800, 416,600, 664,200, and 1,169,000 miles.

Paul W. Stevens, 2322 Westfall Road, Rochester 18, N. Y., has drawn graphs such as that shown here for the period April 8 through 11, 1950, based on the



In this diagram by Paul W. Stevens, the unit of elongation is the maximum value for satellite I. The diameters of the orbits are so small in comparison to Jupiter's distance from the sun that the elongations are assumed proportional to the satellites' distances from the line joining the planet and the sun.

elongations of the satellites as seen from the sun. Mutual eclipses are possible, subject to the factors above mentioned, wherever the curves for any two satellites intersect. The following are times near which observers in the United States may possibly observe the dimming of one satellite by the shadow of another:

April 11, 8:15 UT, **IV** by **II**; 17, 9:45, **III** by **I** (just before an occultation of **III** by Jupiter, the shadow of **I** passing **behind** the planet to the vicinity of **III**); 18, 12:00, **I** by **IV**; 20, 10:45, **I** by **III**; 22, 9:00, **I** by **II**; 26, 11:15, **I** by **II**; 28, 12:00, **I** by **III**; 29, 11:45, **I** by **II**.

These times have been estimated only by 15-minute intervals, and possible eclipses may actually occur half an hour or more before or after the predicted times.

Both Mr. Stevens and Mr. Haas are interested in hearing of any observations of these mutual phenomena of Jupiter. Headquarters of the ALPO are at the Institute of Meteoritics, University of New Mexico, Albuquerque, N. M.

MOON PHASES AND DISTANCE

Full moon	April 2, 20:49
Last quarter	April 9, 11:42
New moon	April 17, 8:25
First quarter	April 25, 10:40
Full moon	May 2, 5:19

	April	Distance	Diameter
Perigee	3d 20h	222,800 miles	33′ 20″
Apogee	18d 19h	252,500 miles	29′ 24″
	May		
Perigee	2d 7h	221,800 miles	33′ 28″

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of April, respectively.

STARS FOR APRIL

RIGHT ASCENSION is the celestial equivalent of terrestrial longitude. It is measured eastward from the vernal equinox, 1^h, 2^h, 3^h, and so on, 24 equal hours corresponding to 360 degrees completely around the sky. Each circle of right ascension, or hour circle, has two halves on opposite sides of the sky. Thus, the hour circle that passes through the vernal equinox, marked either 0^h or 24^h, also passes through the autumnal equinox, where it is marked 12^h.

In April the autumnal equinox, situated among the stars in Virgo, is in the eastern sky at sunset, as shown on the chart for the evening sky above.

It is a property of the stereographic projection that all circles on a sphere are projected as parts of circles on the flat surface. Each great circle of right ascension is marked by four points on our charts, and through these circles of appropriate radius may be drawn. The pole is one of these points in every case; one point is along the equator; and two points are marked along the 40° horizon, one differing from the other by 12 hours in each instance. Occasionally, one of these points, or its label, is omitted because of lack of space in that part of the chart, or because a star lies in that position.